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(12) **United States Patent**
Kawakami

(10) **Patent No.: US 9,449,639 B2**
(45) **Date of Patent: Sep. 20, 2016**

(54) **MEDIUM TRANSPORTING UNIT AND MEDIUM PROCESSING APPARATUS**

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(73) Assignee: **Seiko Epson Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/306,840**

(22) Filed: **Jun. 17, 2014**

(65) **Prior Publication Data**

US 2014/0348626 A1 Nov. 27, 2014

Related U.S. Application Data

(63) Continuation of application No. 13/860,277, filed on Apr. 10, 2013, now Pat. No. 8,789,075, which is a continuation of application No. 12/080,301, filed on Apr. 2, 2008, now Pat. No. 8,438,584.

(30) **Foreign Application Priority Data**

Apr. 5, 2007 (JP) 2007-099879

(51) **Int. Cl.**

G11B 17/02	(2006.01)
G11B 17/022	(2006.01)
B41J 3/407	(2006.01)
G11B 17/08	(2006.01)
G11B 23/40	(2006.01)

(52) **U.S. Cl.**

CPC ***G11B 17/022*** (2013.01); ***B41J 3/4071*** (2013.01); ***G11B 17/08*** (2013.01); *G11B 23/40* (2013.01)

(58) **Field of Classification Search**

CPC G11B 17/08; G11B 17/022

USPC 720/600

See application file for complete search history.

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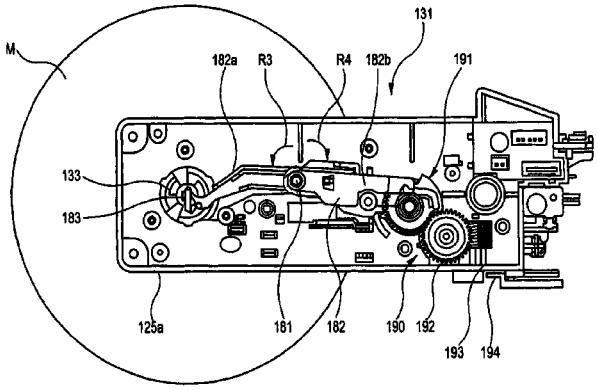
Primary Examiner — Brian Miller

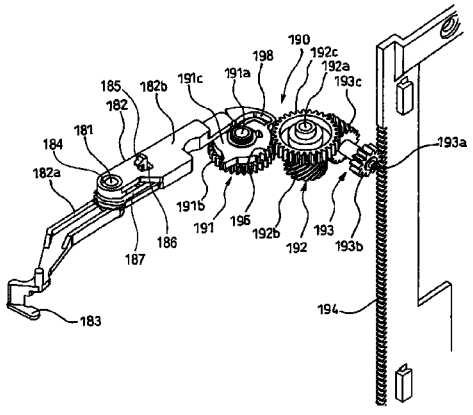
(74) *Attorney, Agent, or Firm* — Nutter McClennen & Fish LLP; John J. Penny, Jr.

(57) **ABSTRACT**

A holding mechanism is operable to hold a top medium from a plurality of plate-shaped media accommodated in a stacker in a stacked manner. A transport arm supports the holding mechanism. The transport arm is provided with a separation mechanism operable to separate a second medium positioned just below the top medium which is held by the holding mechanism.

8 Claims, 28 Drawing Sheets





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U.S. Appl. No. 13/860,277, filed Apr. 10, 2013, Medium Transporting Unit and Medium Processing Apparatus.

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FIG. 1

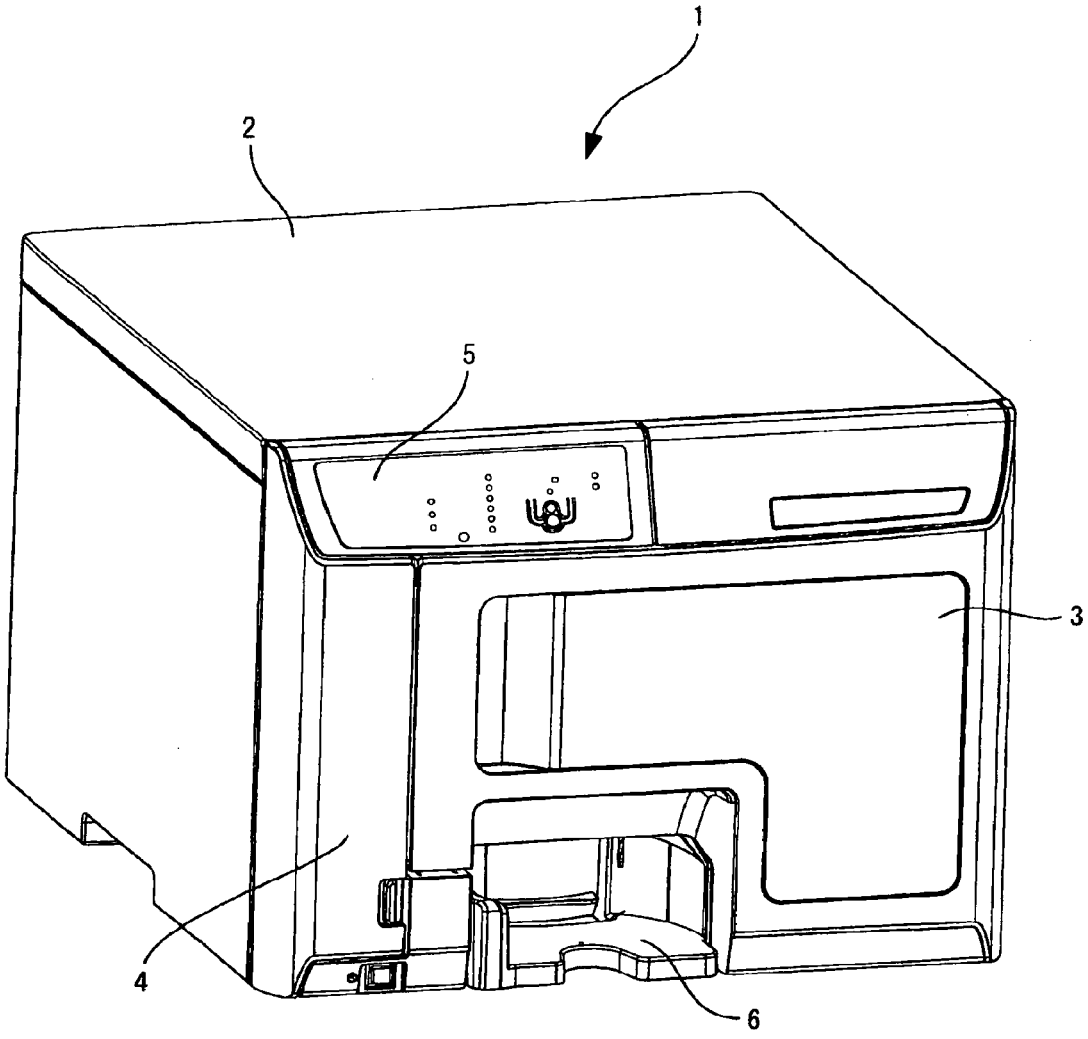
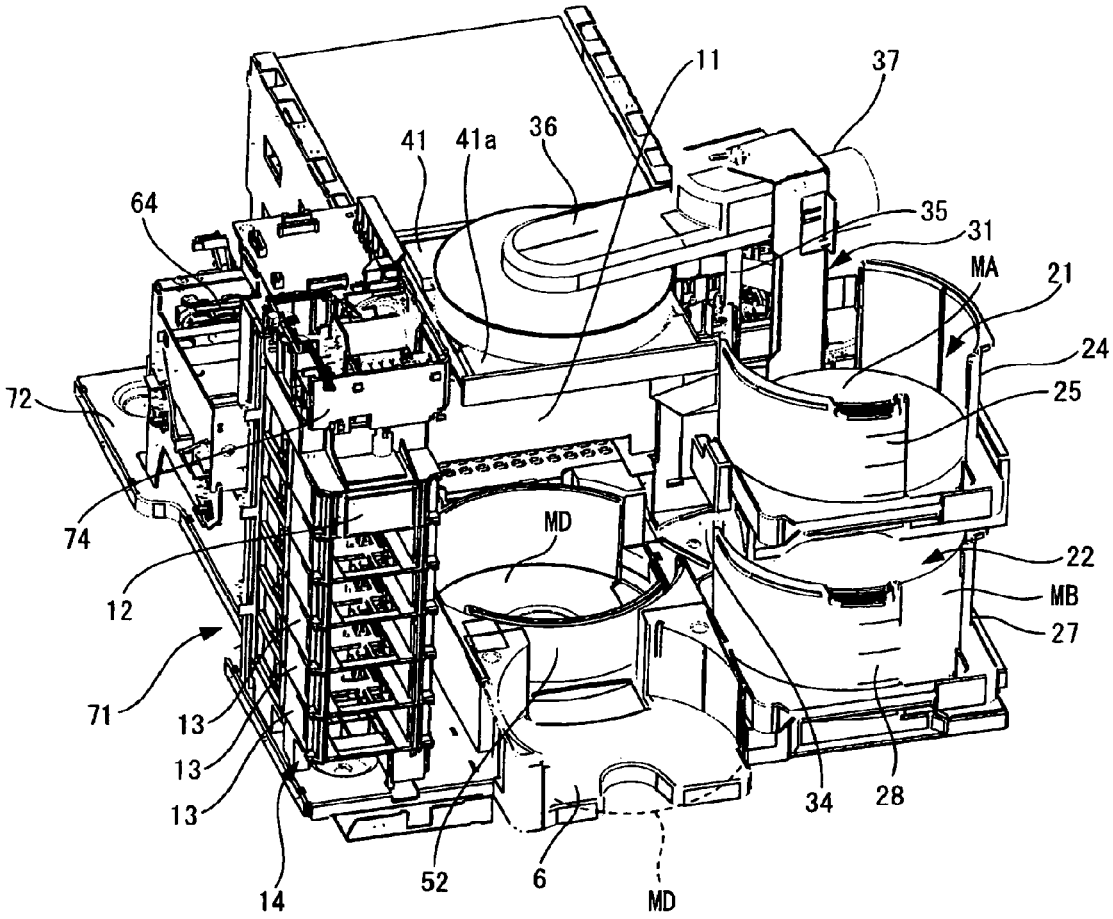


FIG. 2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36
64
35
31
MA
21
24
72
25
74
MD
22
12
MB
27
71
13
13
13
34
28
14
52
6
MD

FIG. 3

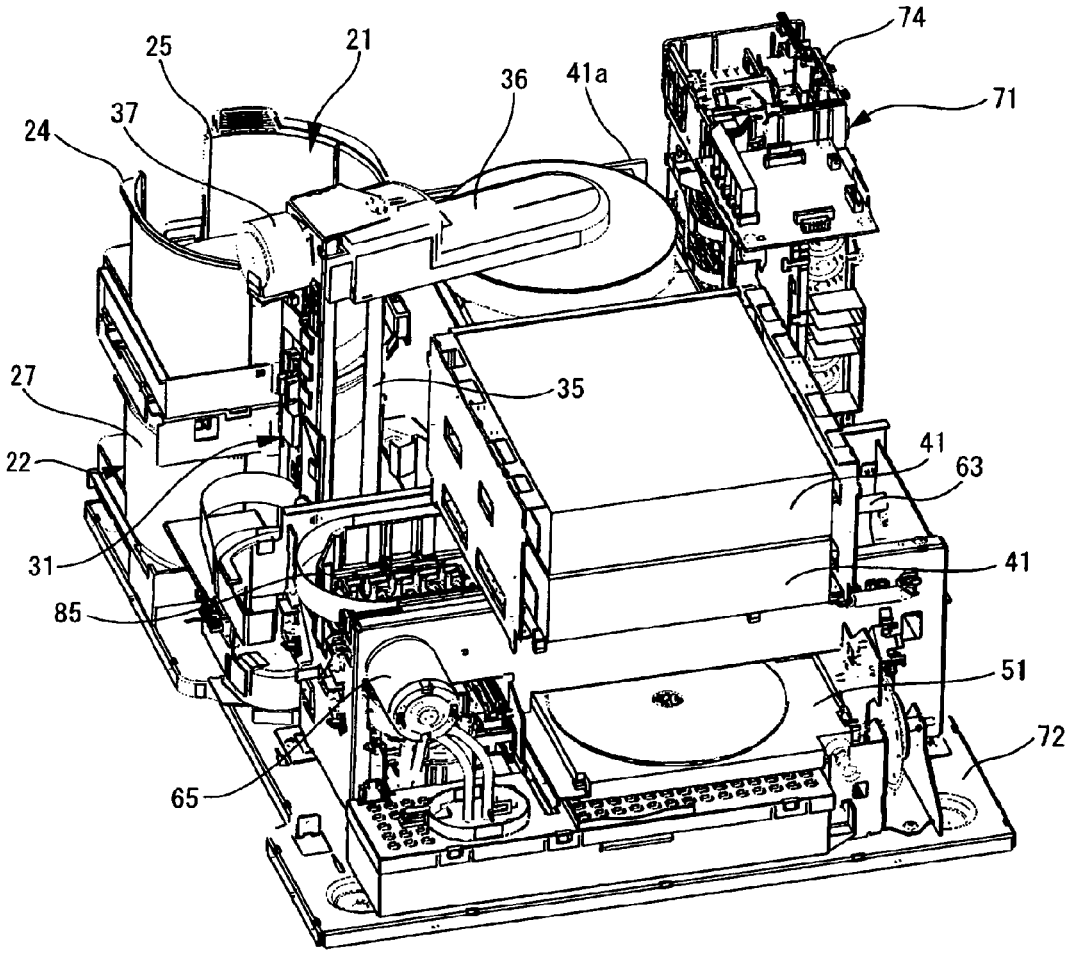


FIG. 4

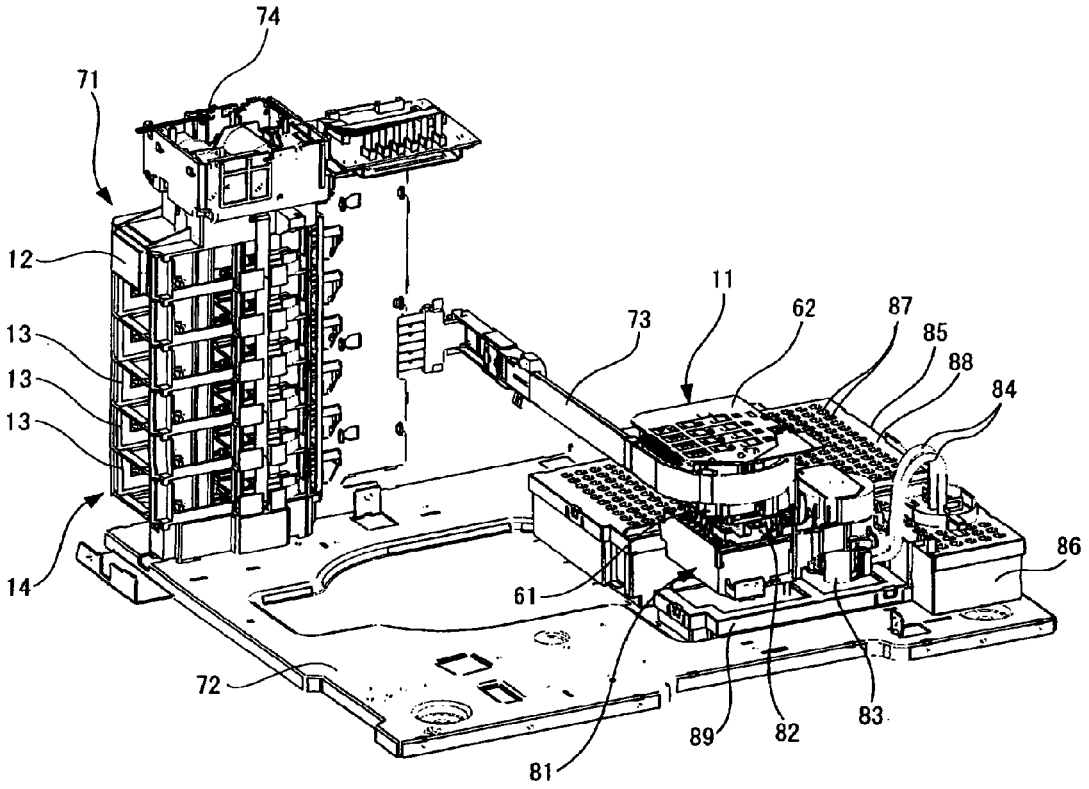


FIG. 5

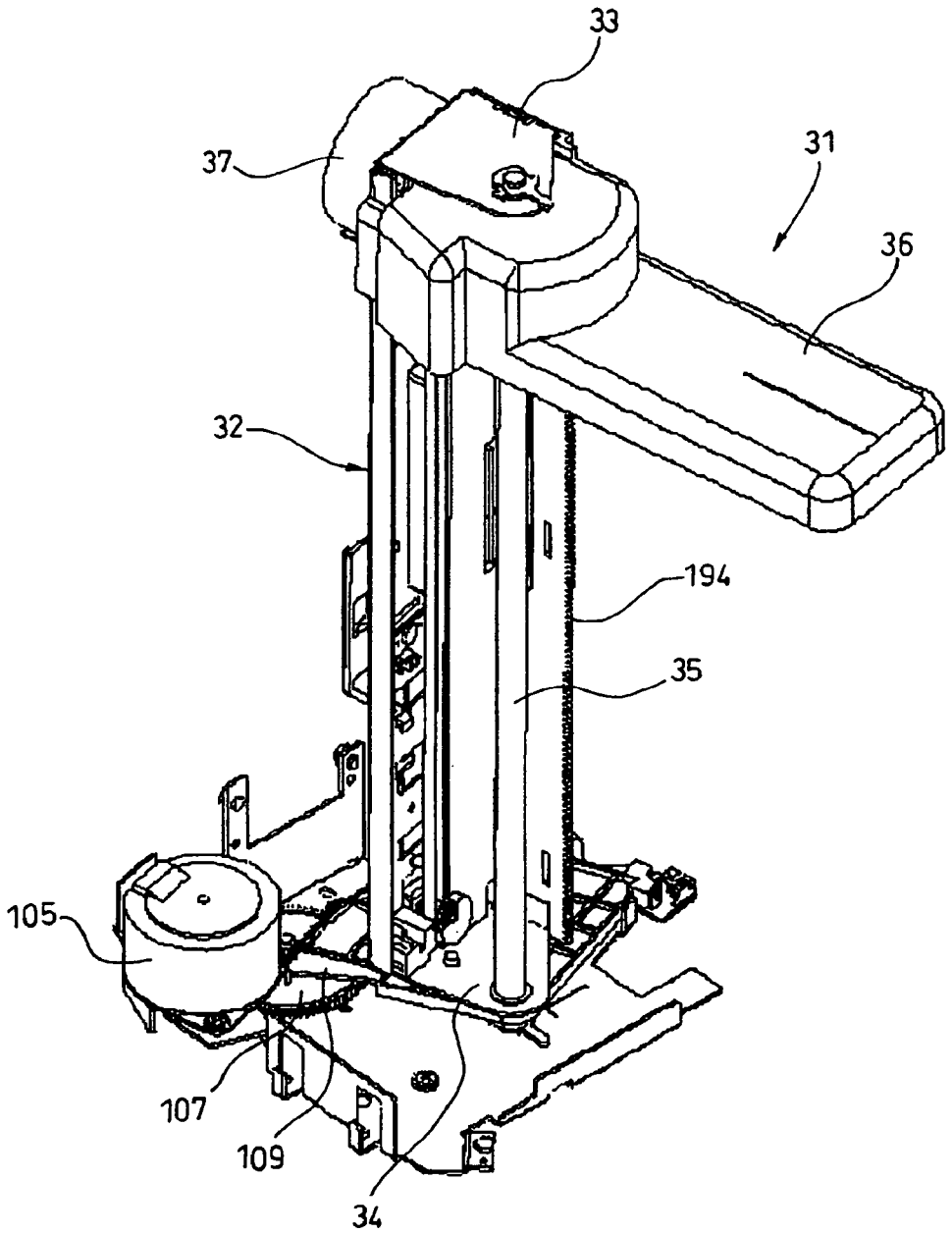


FIG. 6

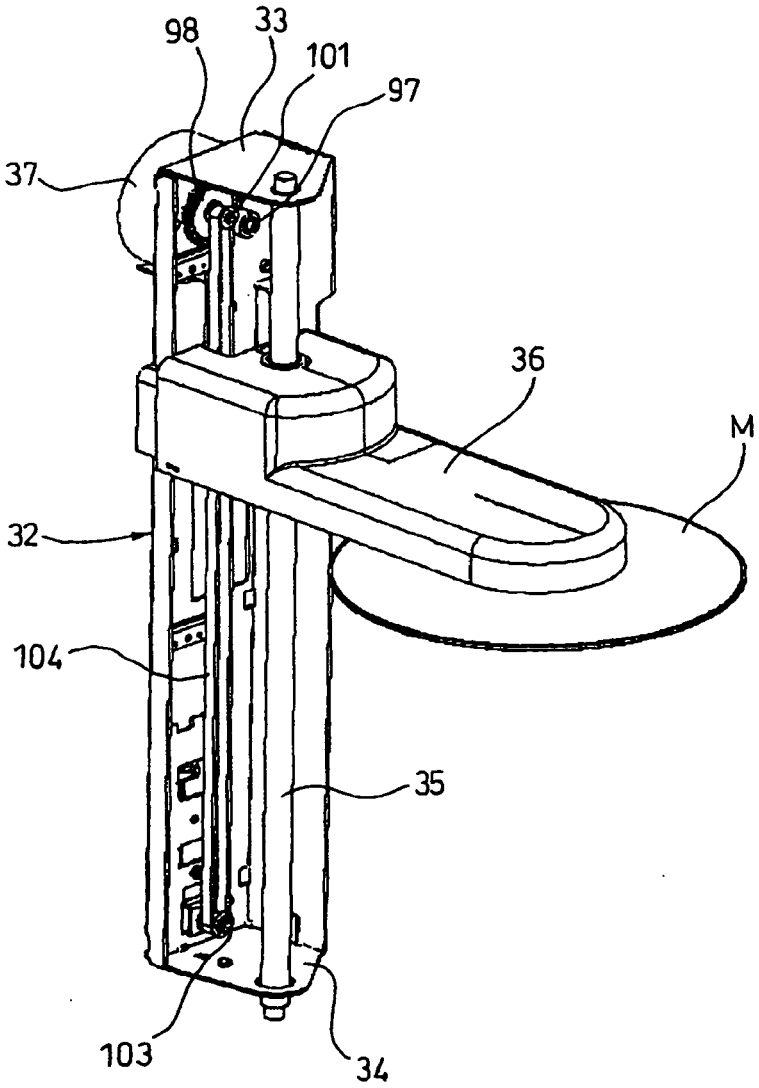


FIG. 7

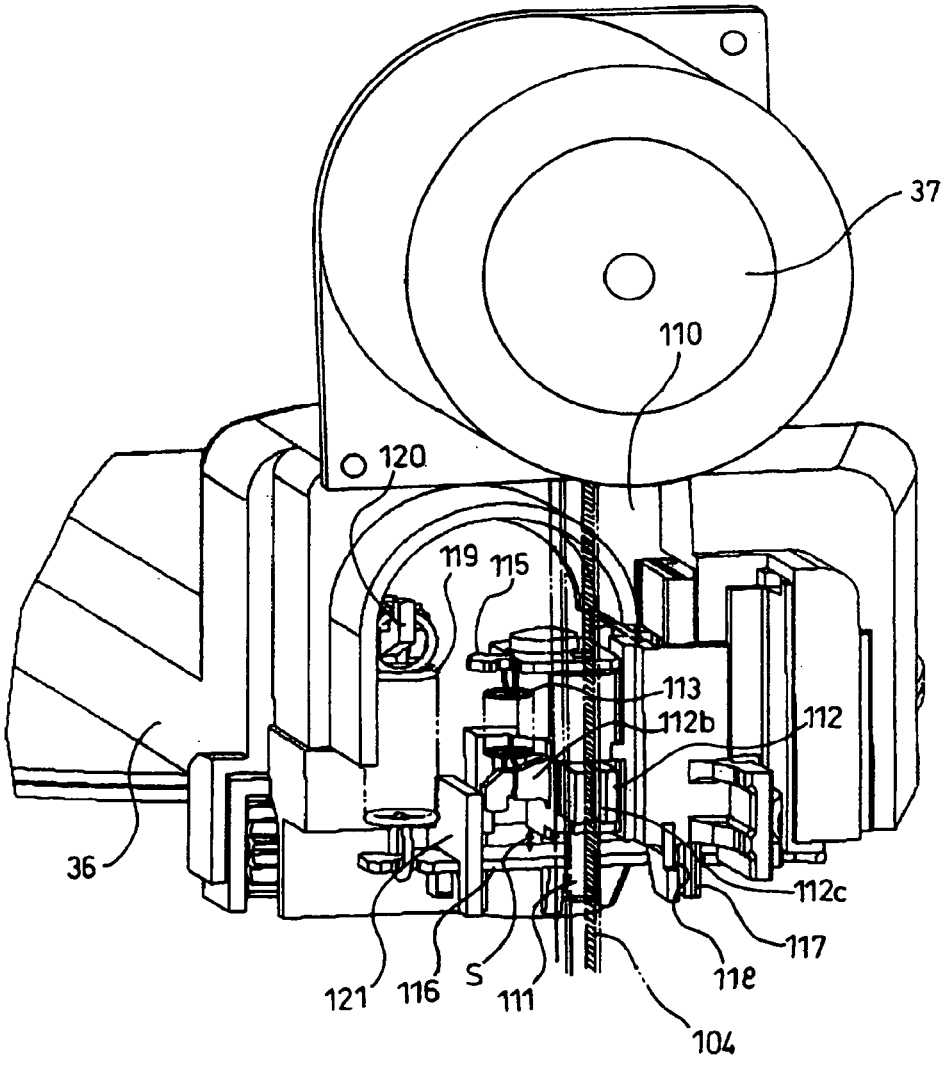
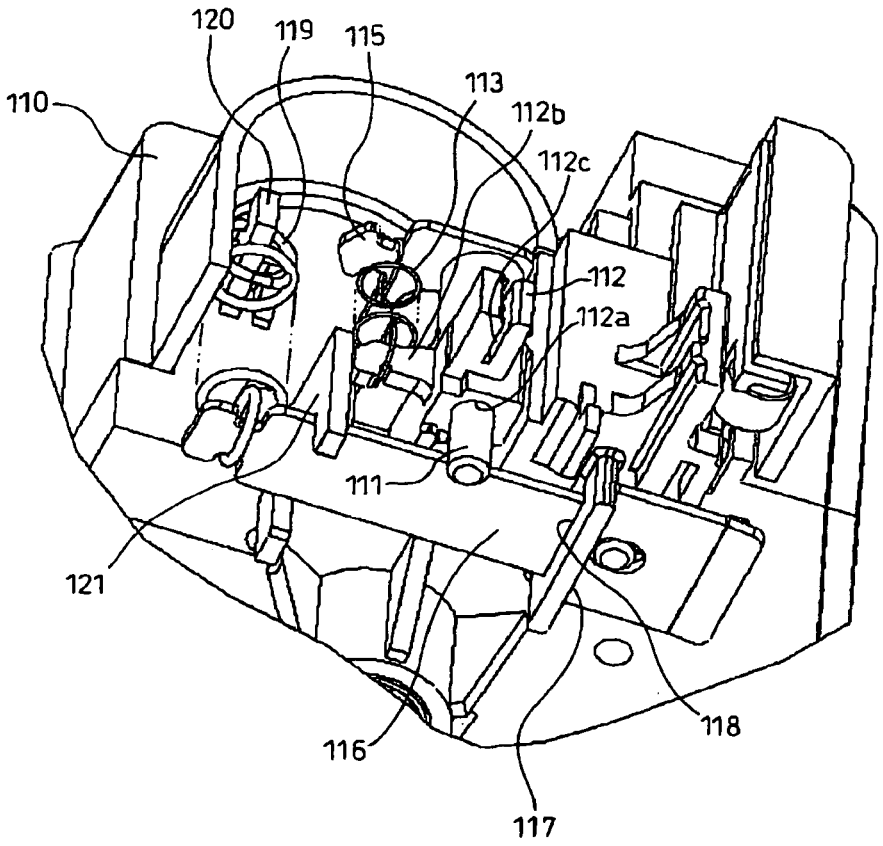
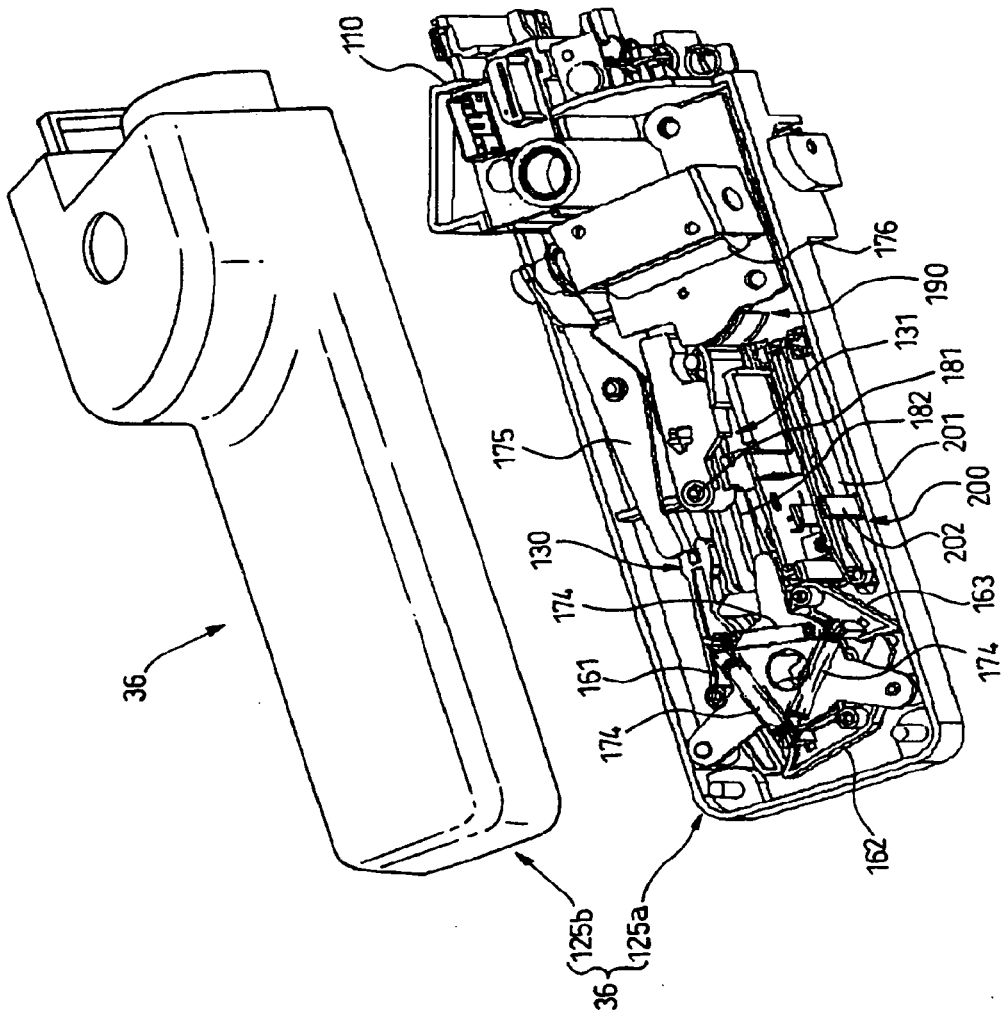


FIG. 8

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176
190
131
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182
201
200
202
163
174
162
175
130
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161
174
36
125b
125a
36

FIG. 9

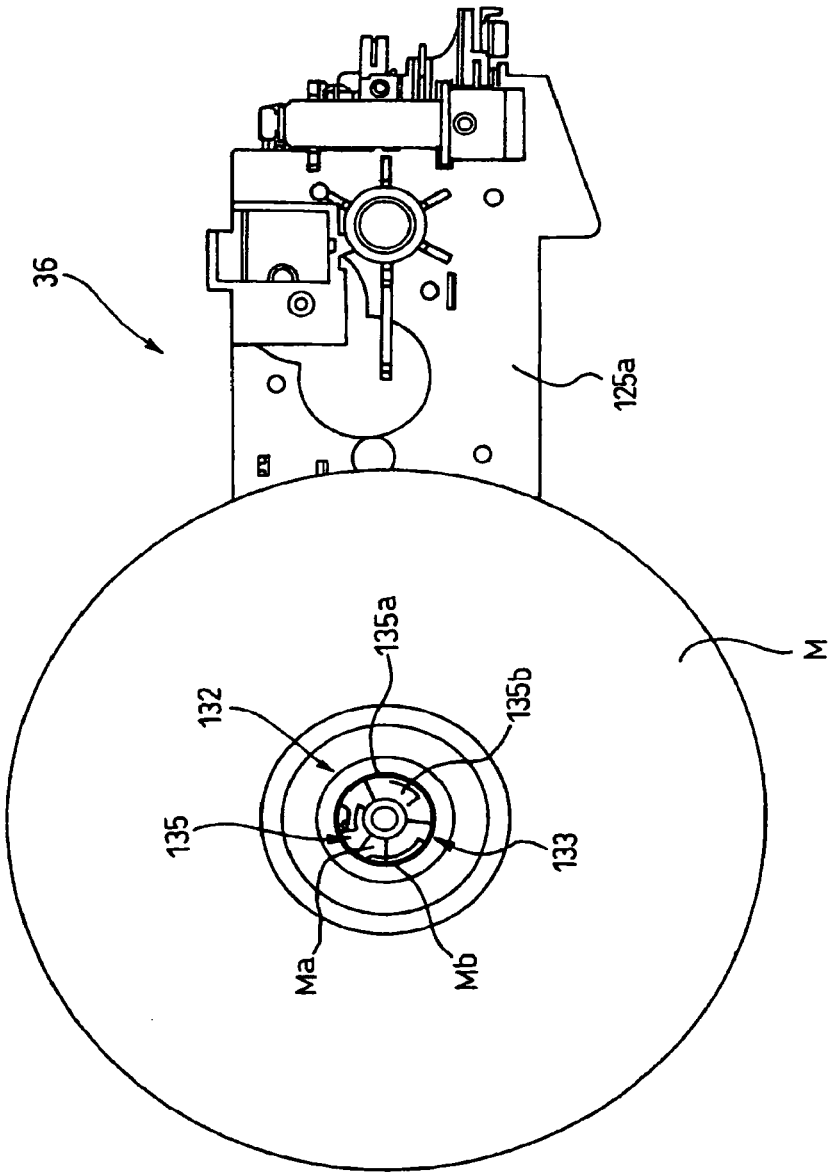


FIG. 10

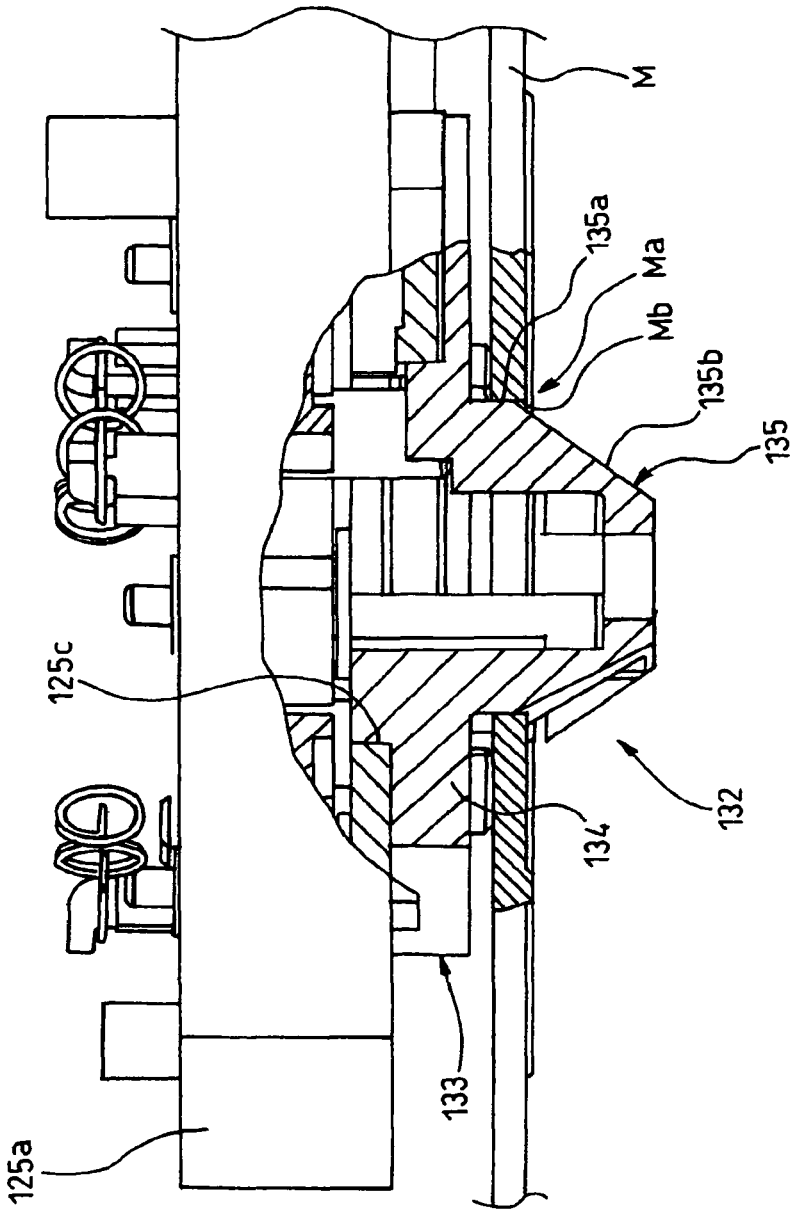
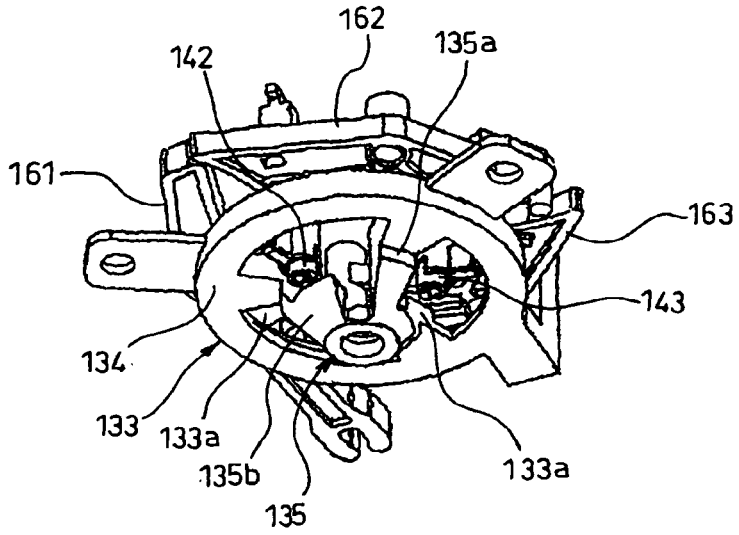


FIG. 11

FIG. 12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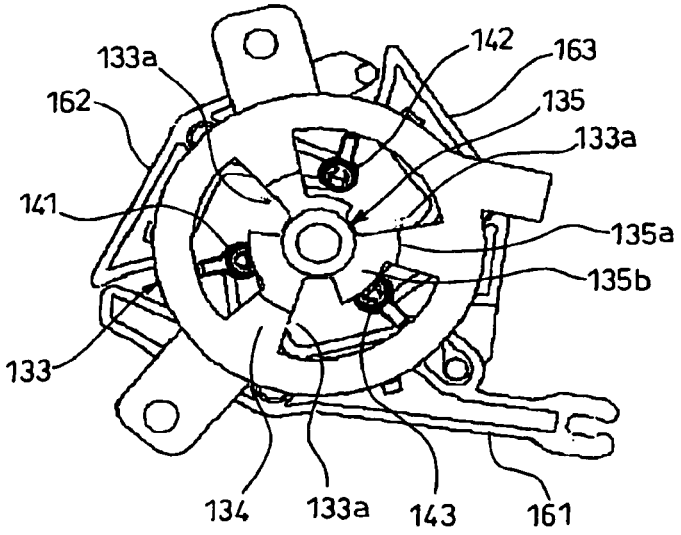
142
135a
161
163
143
134
133
133a
135b
135
133a

FIG. 13


133a
142
163
162
135
133a
141
135a
135b
133
134
133a
143
161

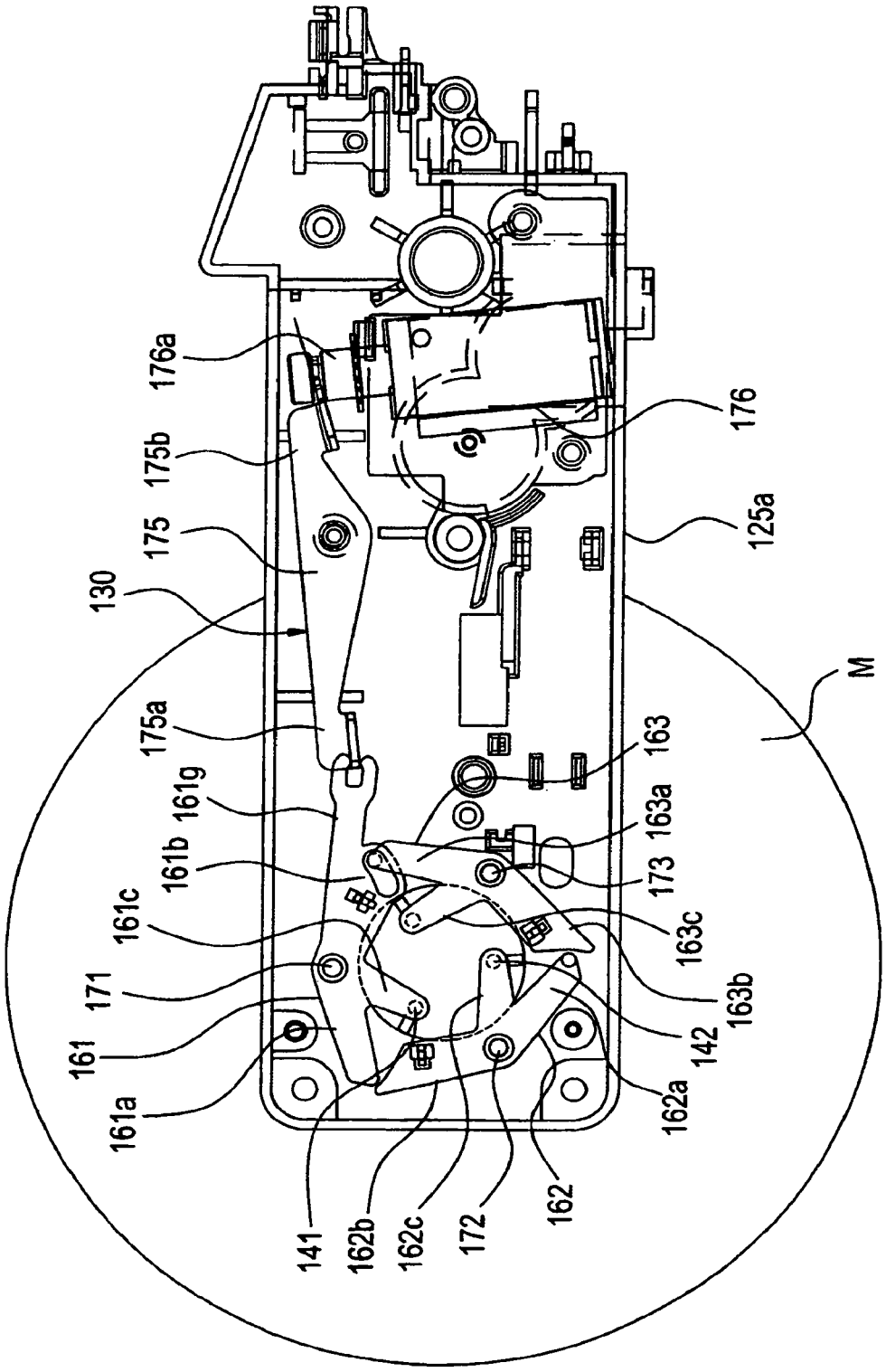
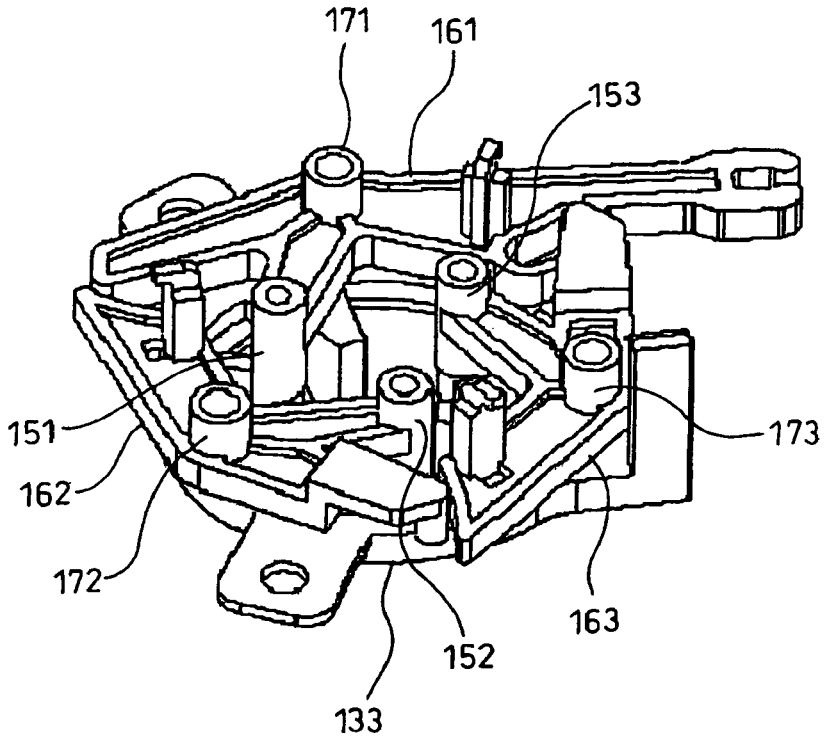

176a
175b
175
130
175a
161g
161b
161c
171
161
161a
141
162b
162c
172
162
162a
142
163b
163c
173
163a
163
M
125a
176

FIG. 14

FIG. 15



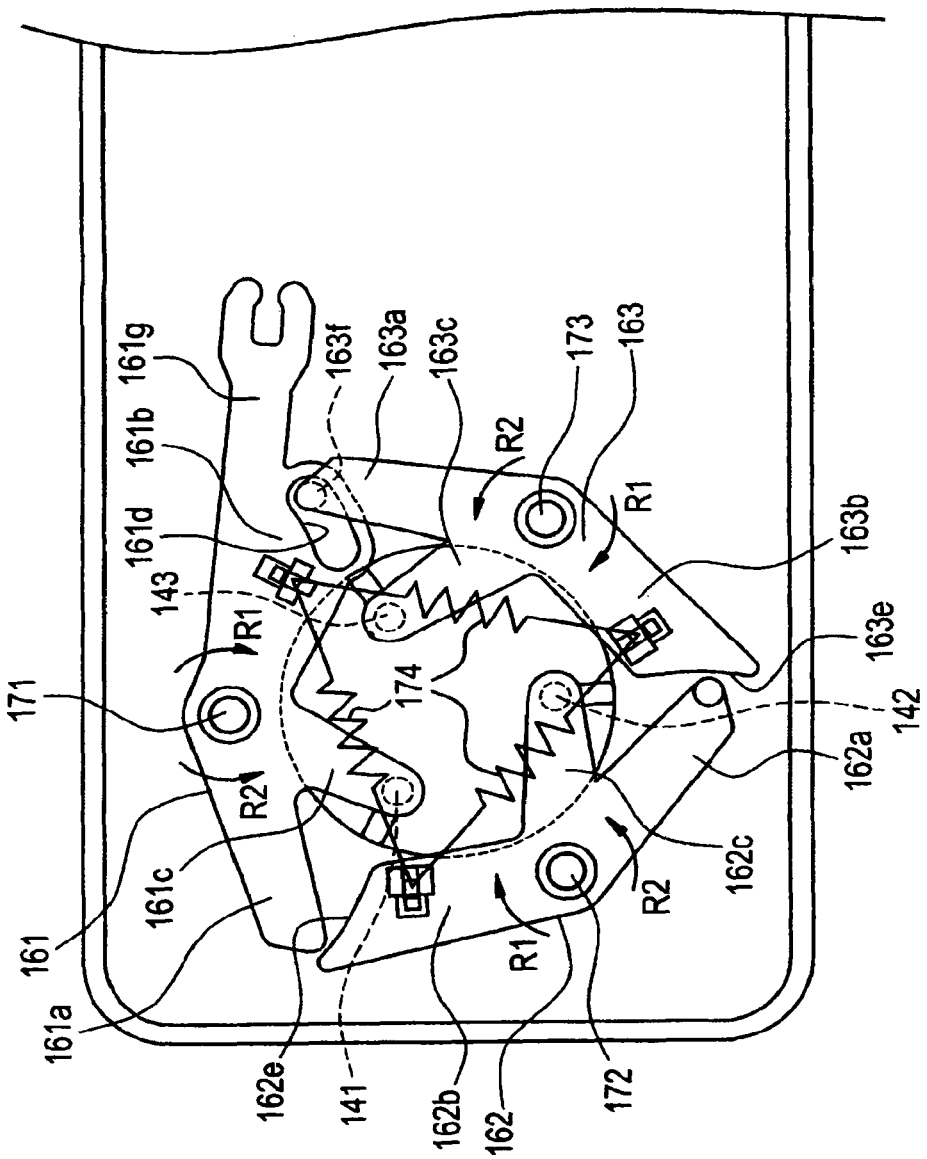

161g
161b
161d
143
171
161c
161
161a
162e
141
162b
162
172
162c
162a
142
163b
163e
174
163f
163a
163c
173
163
R1
R2

FIG. 16

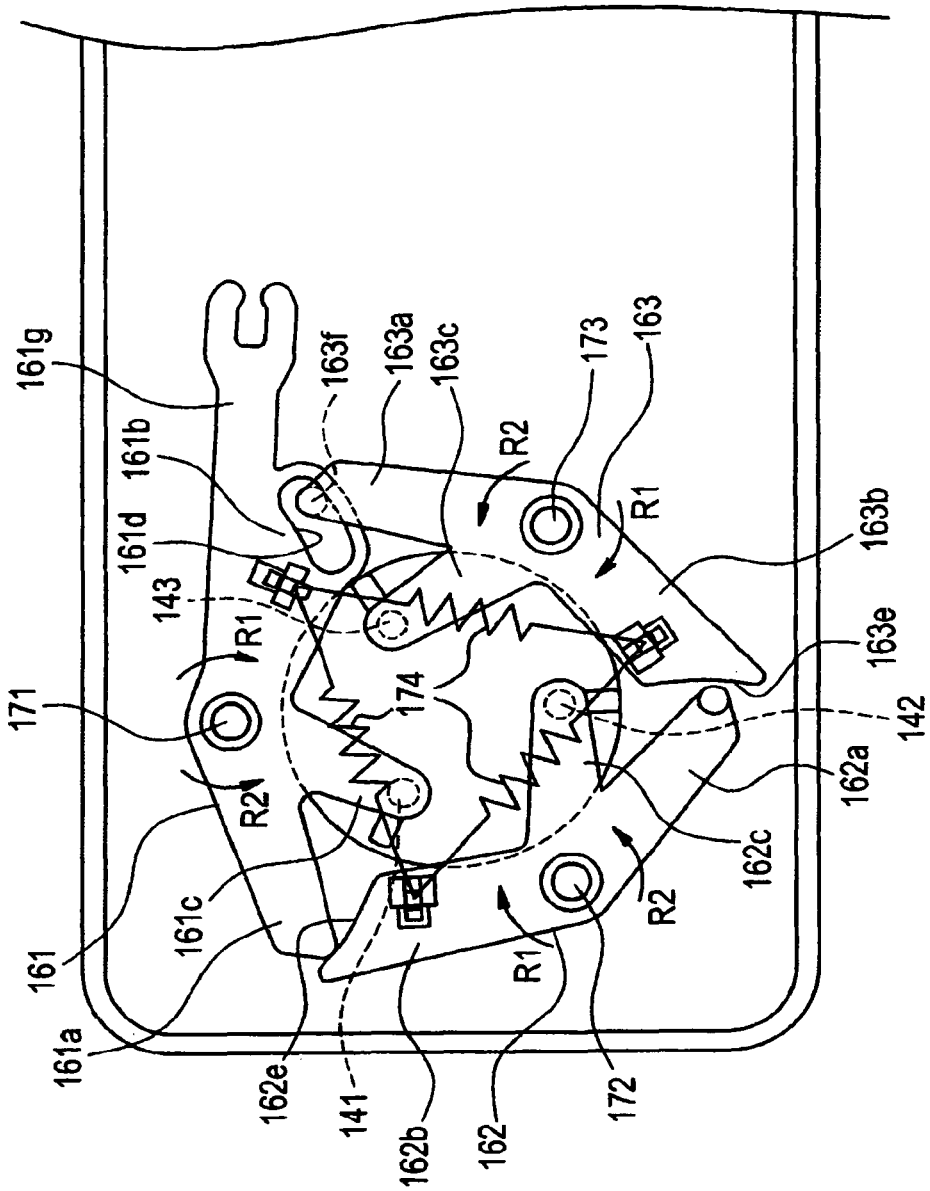

161g
161b
161d
143
171
161
161a
161c
162e
141
162b
162
172
174
163f
163a
163c
173
163
163b
163e
142
162a
162c
R1
R2

FIG. 17

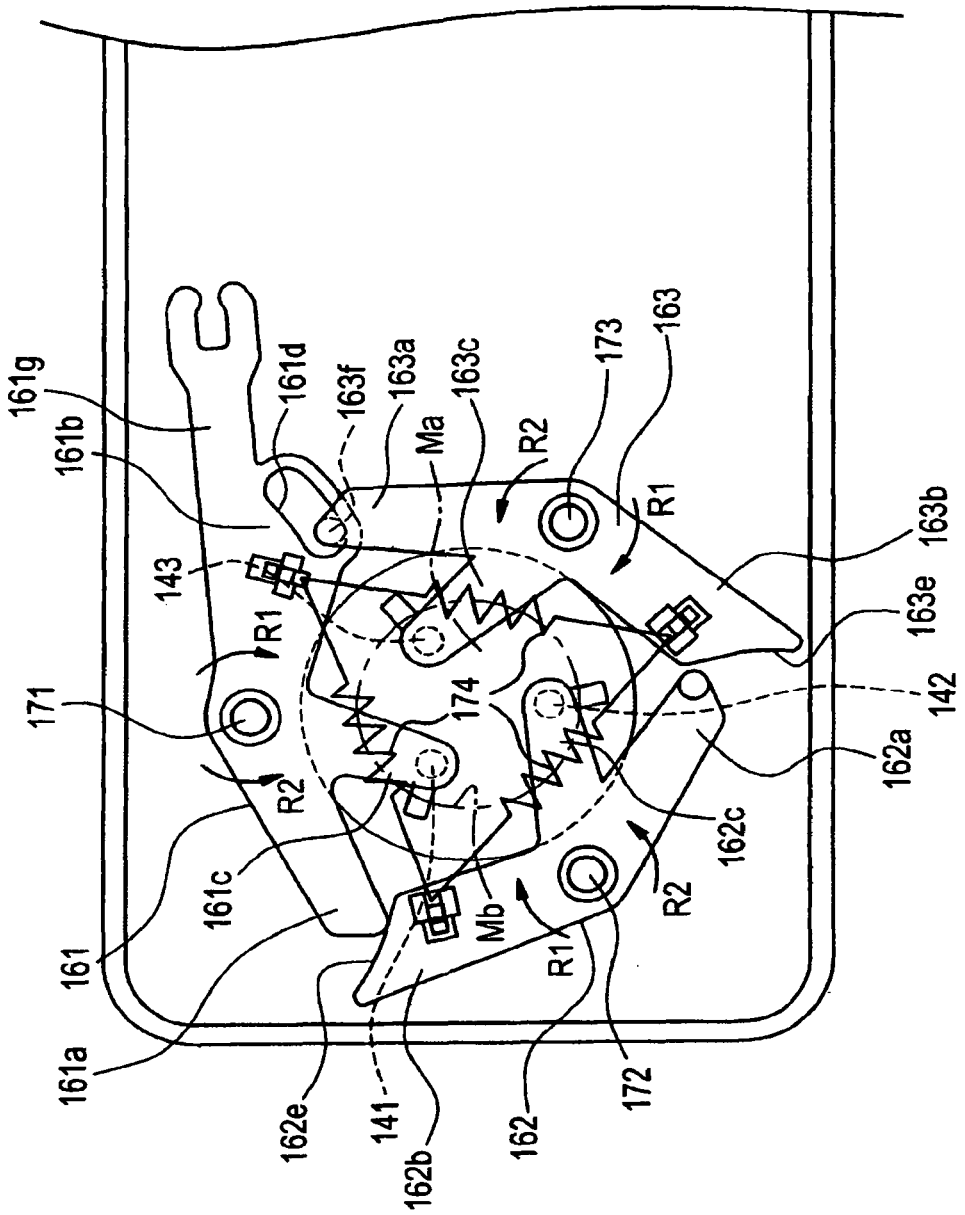

161g
161b
161d
163f
163a
163c
173
163
Ma
R2
R1
143
163b
163e
R1
171
174
142
162a
R2
161c
162c
Mb
R2
R1
161
161a
162e
141
162b
162
172

FIG. 18

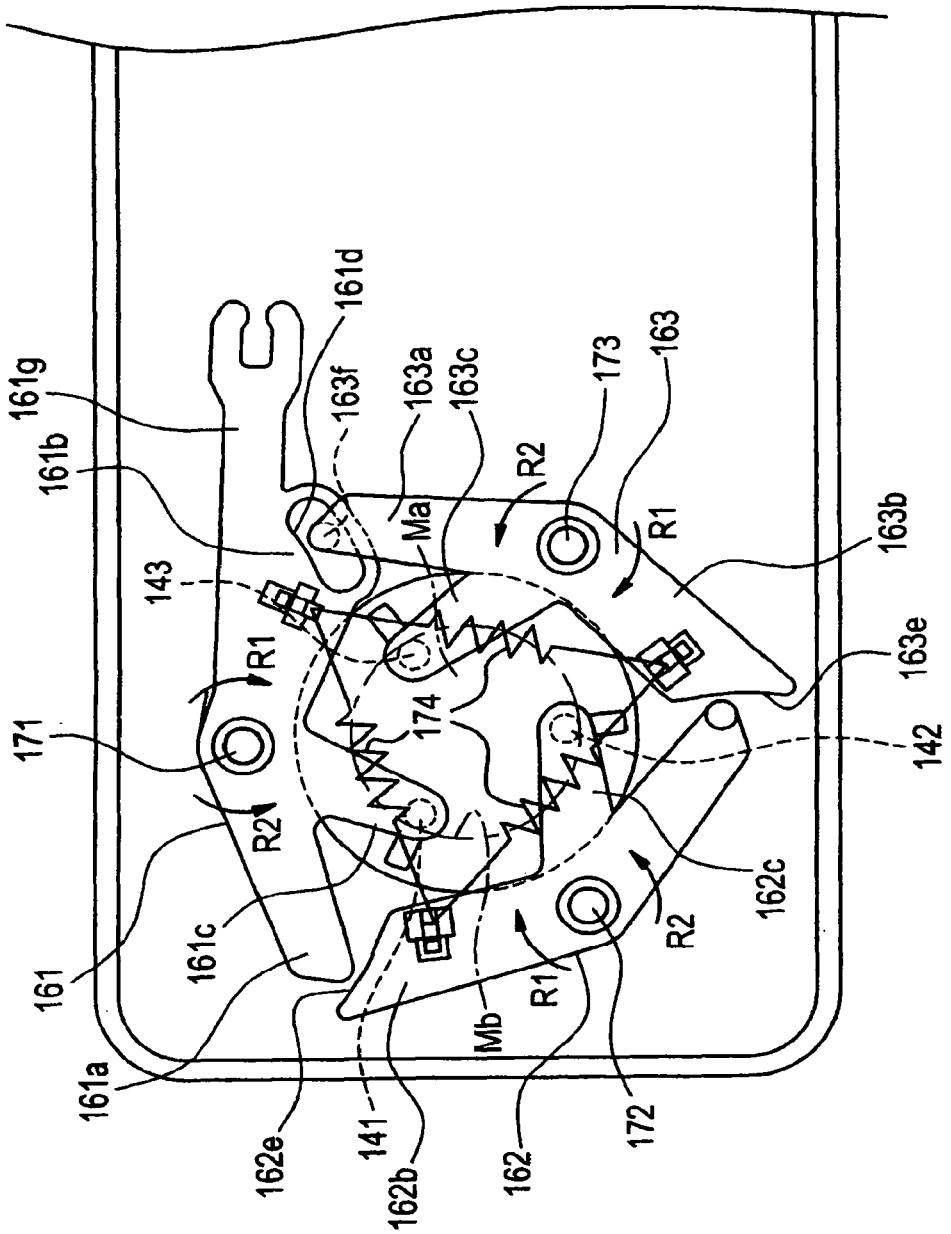
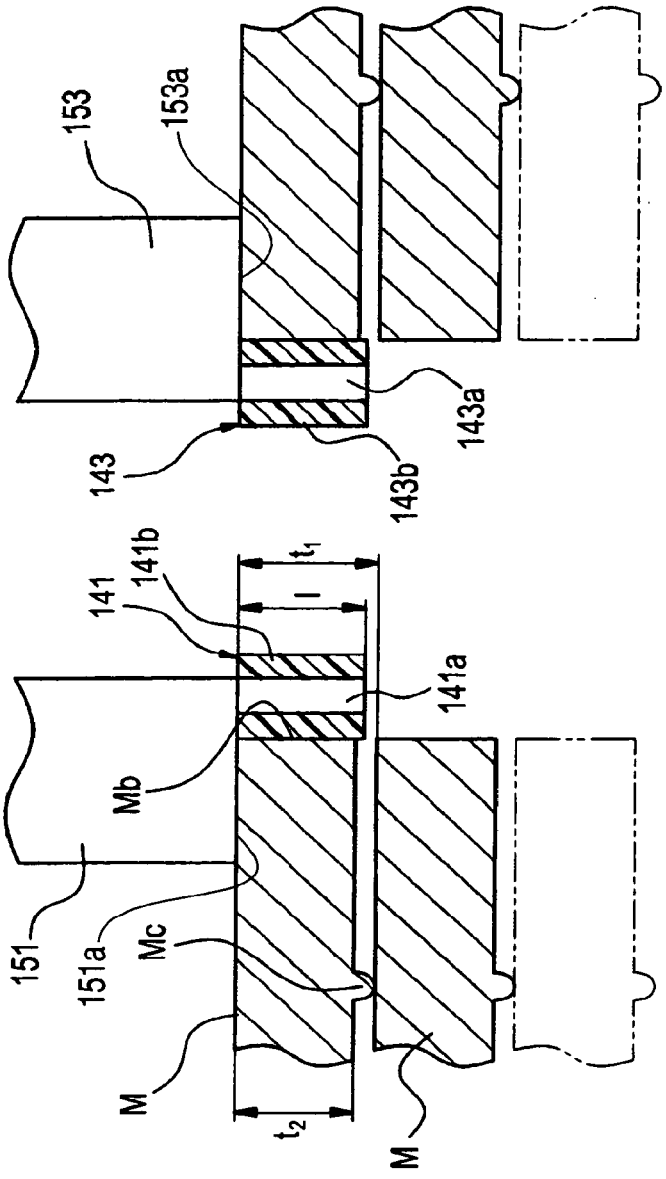

161g
161b
161d
163f
163a
163c
173
163
R2
Ma
R1
163b
143
R1
174
163e
171
142
R2
162c
161c
R2
161
R1
Mb
161a
162e
141
162b
162
172

FIG. 19

FIG. 20



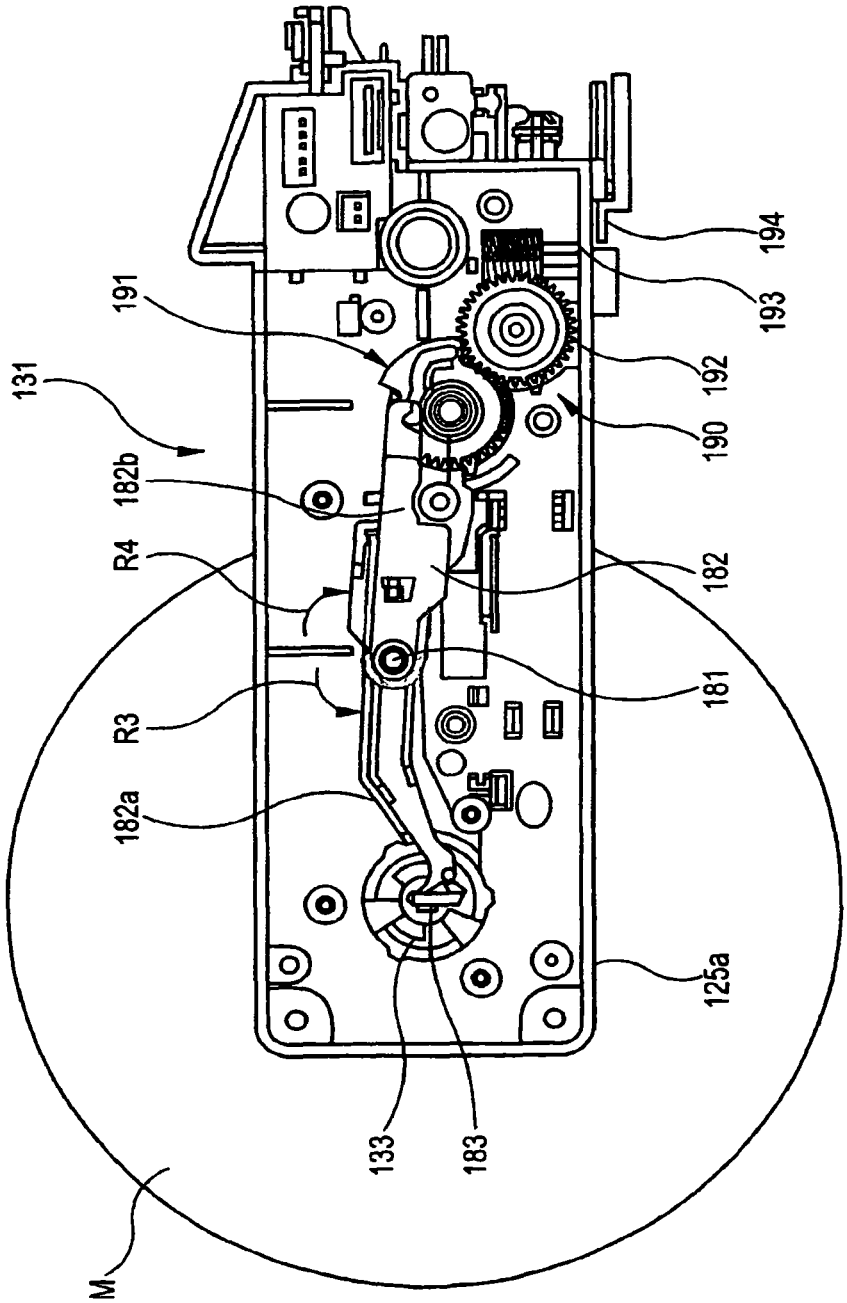


FIG. 21

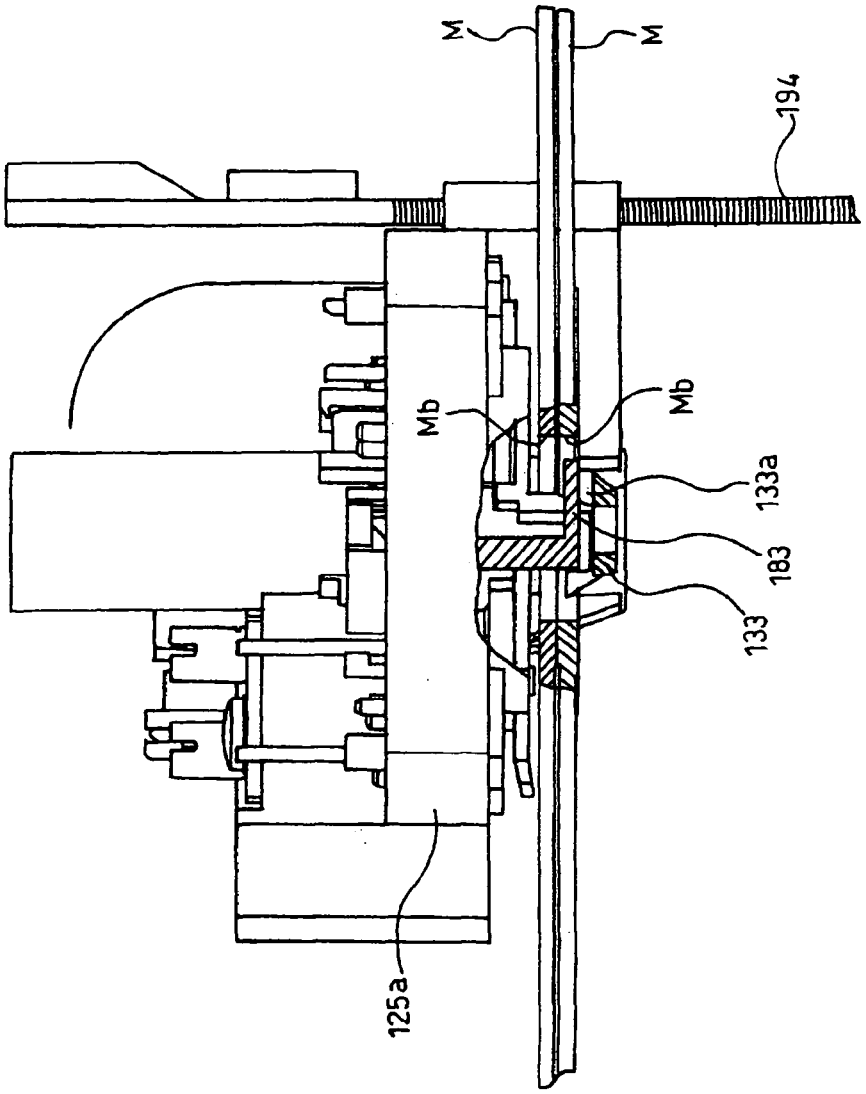
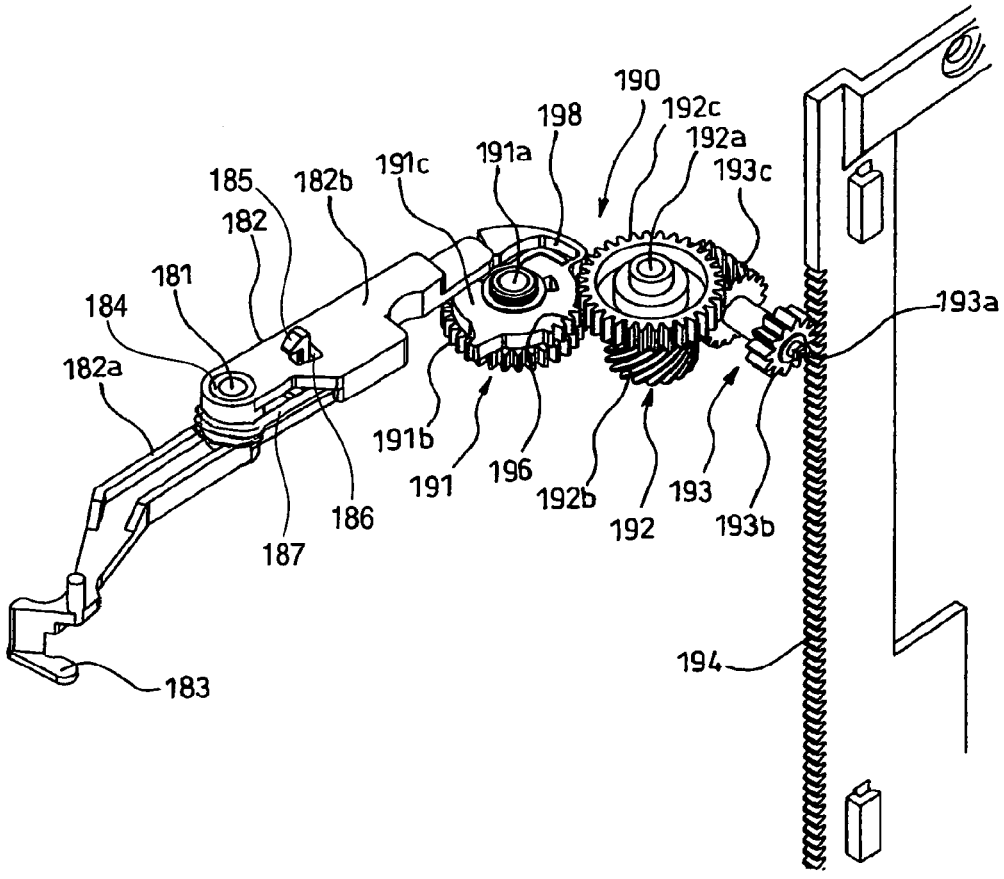


FIG. 22

FIG. 23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192c
198
192a
191a
193c
191c
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181
184
193a
182a
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191
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192b
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193
193b
186
187
194
183

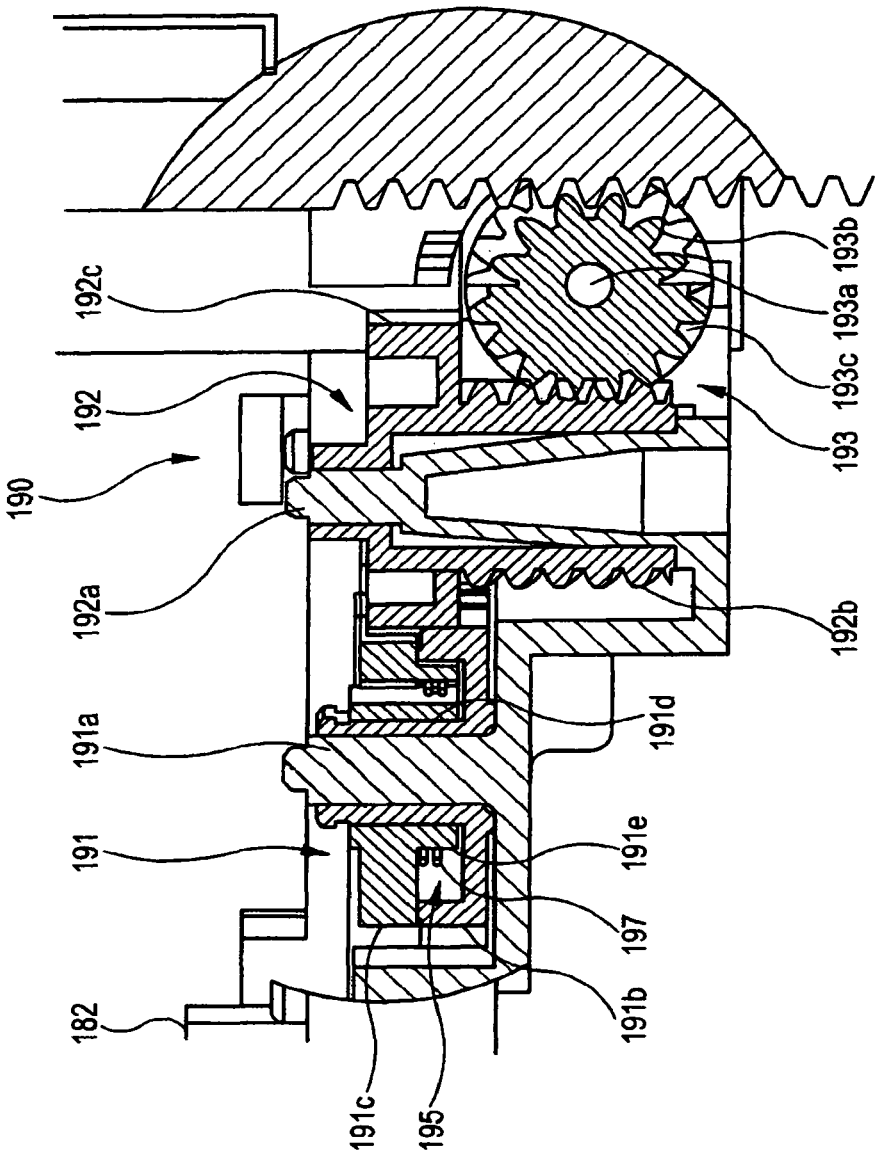

190
192
192c
192a
191
191a
182
191c
195
197
191b
191e
191d
192b
193
193c
193a
193b

FIG. 24

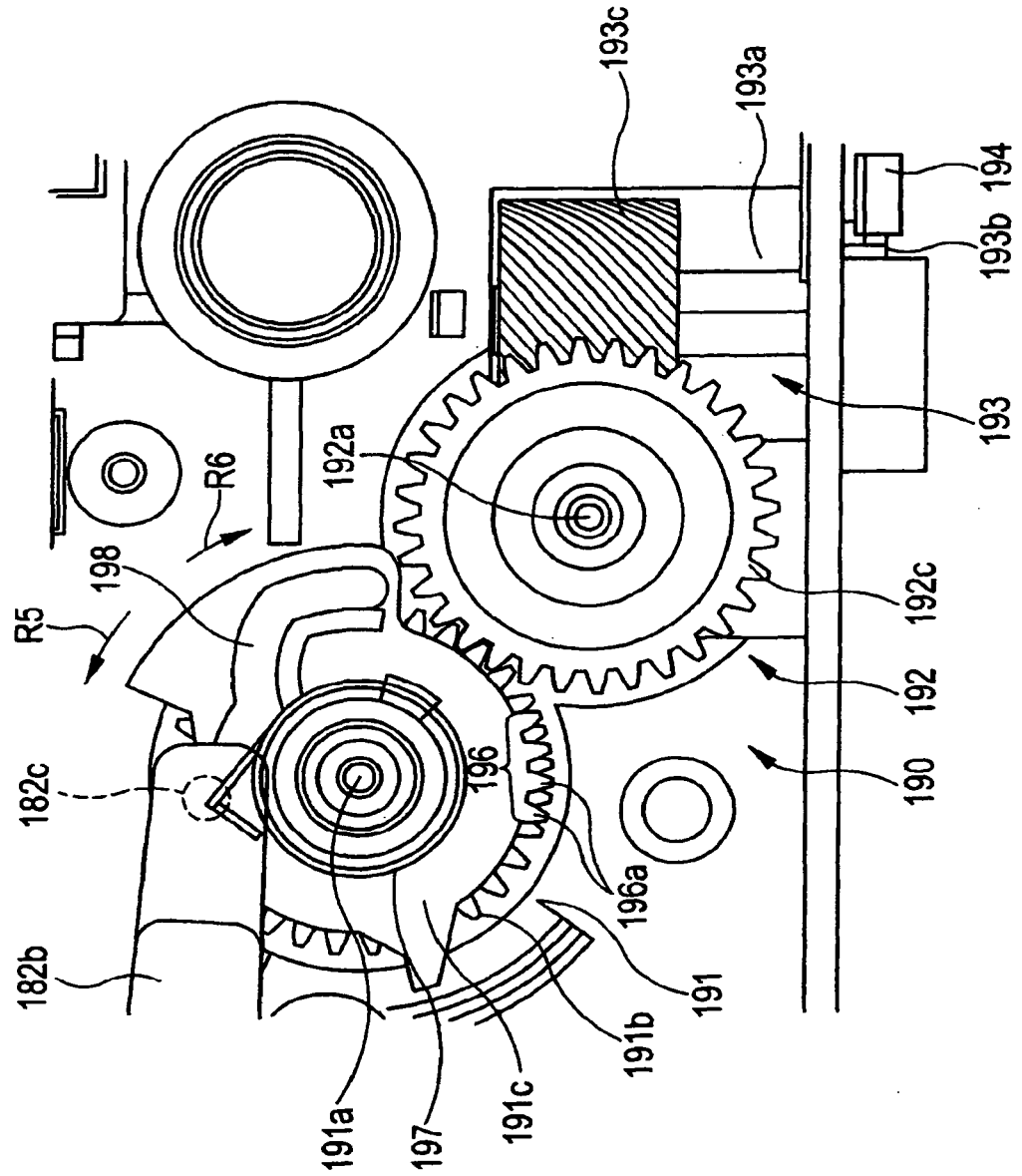

193c
193a
194
193b
193
192a
R6
198
R5
192c
192
182c
196
190
196a
182b
191
191b
191a
197
191c

FIG. 25

FIG. 26

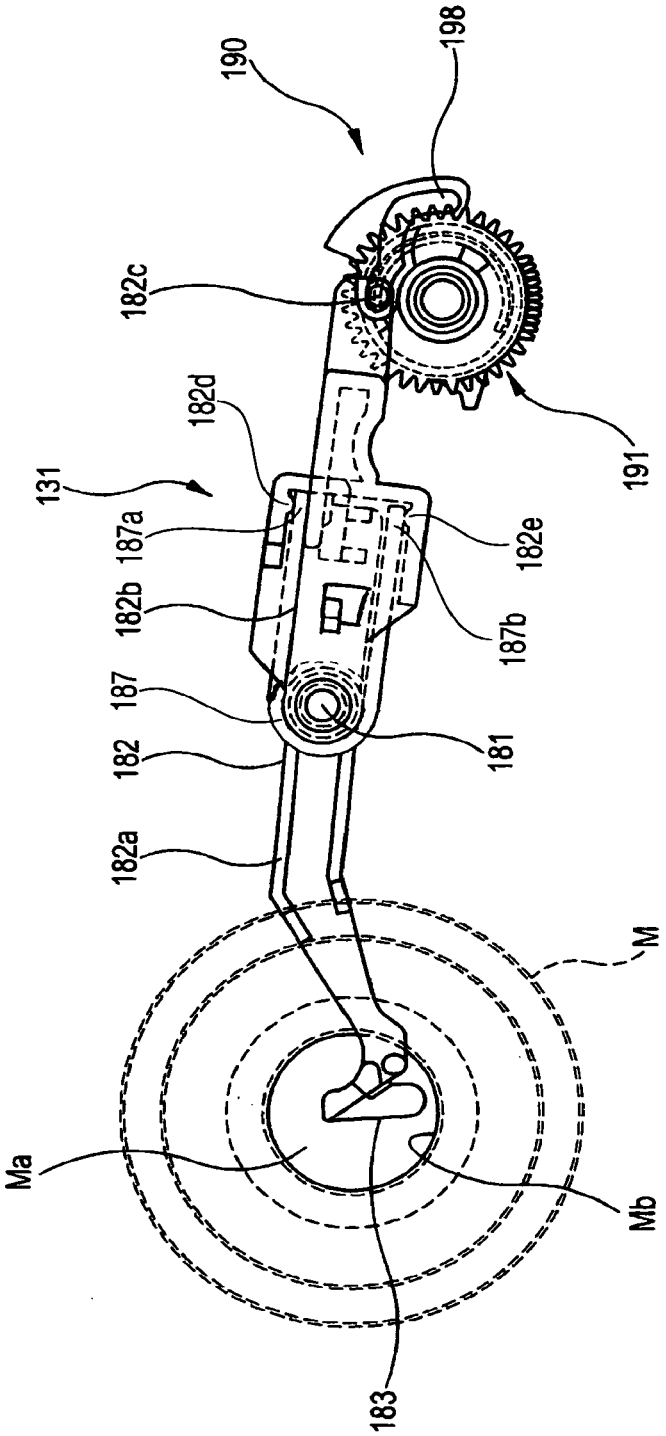

190
198
182c
182d
131
187a
182e
182b
187b
187
181
182
182a
M
Ma
Mb
183
191

FIG. 27

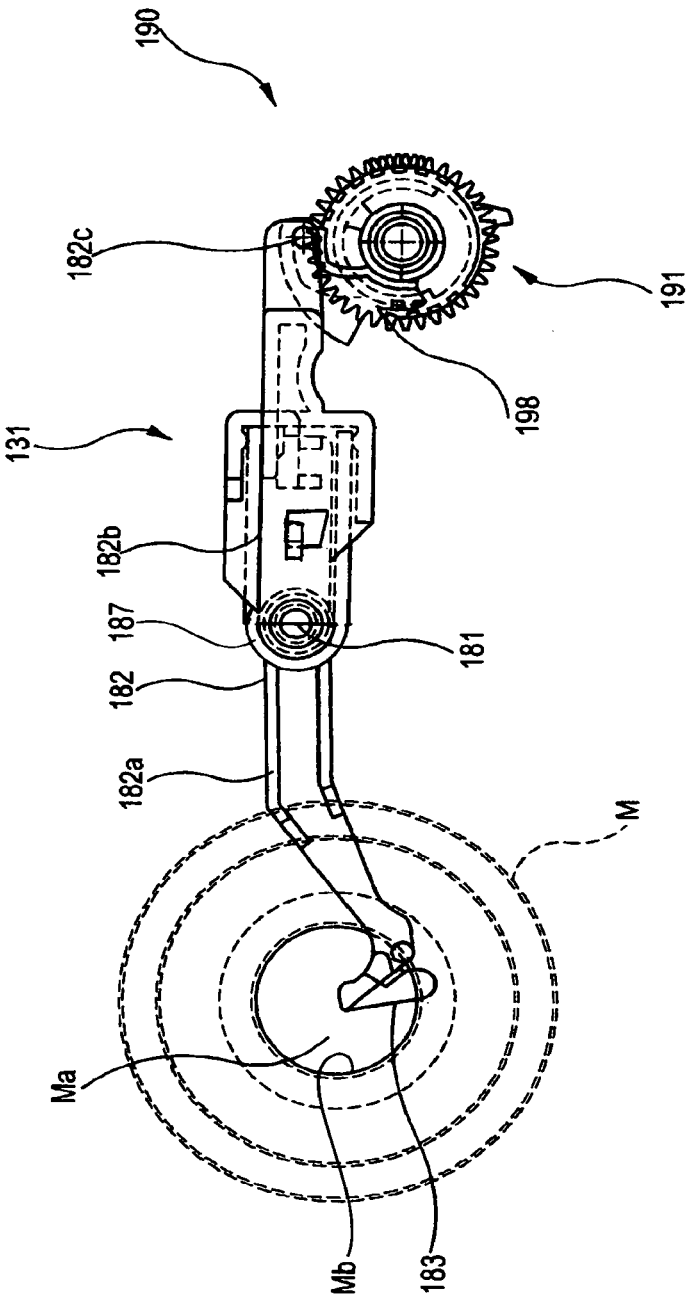


FIG. 28

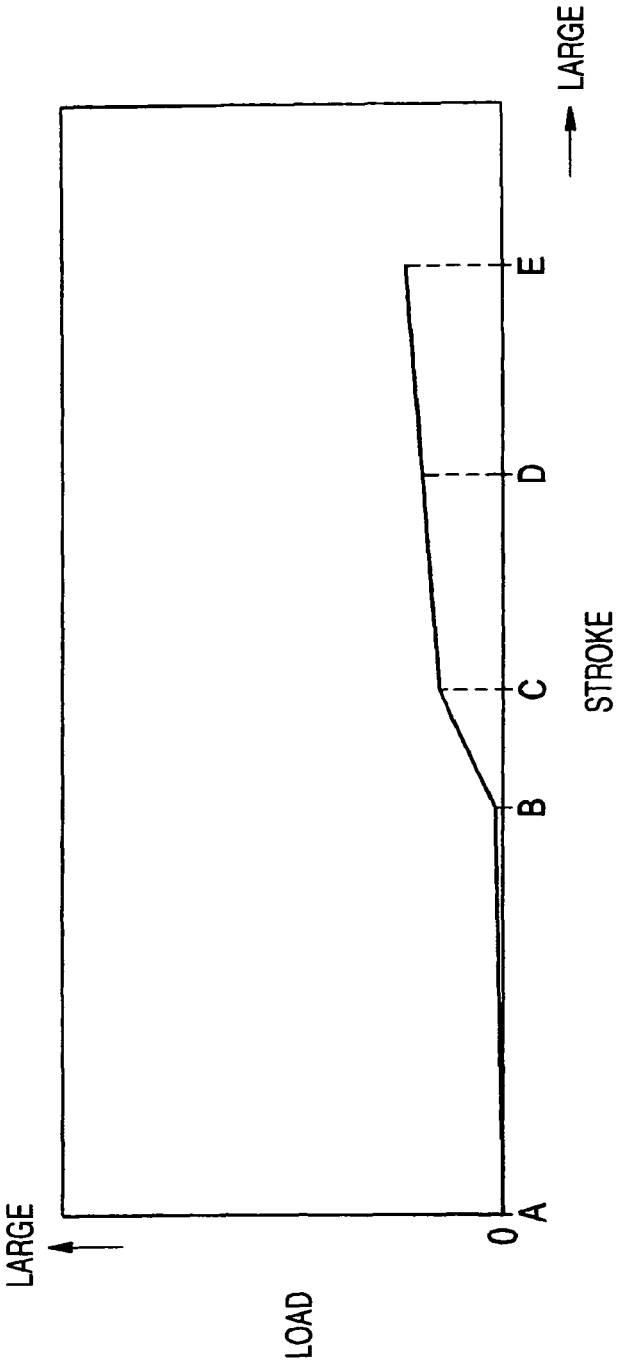
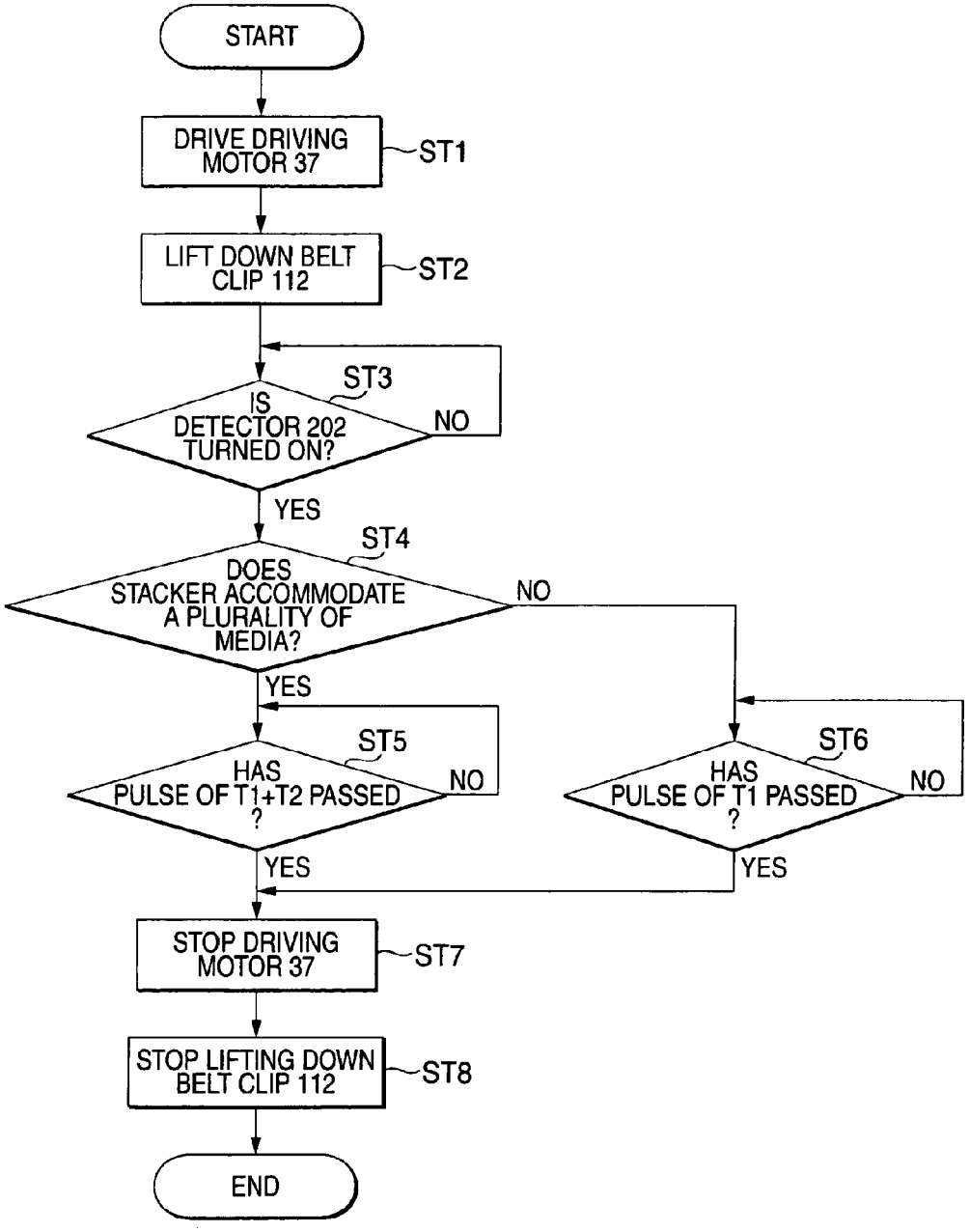


FIG. 29


START
DRIVE DRIVING MOTOR 37
ST1
LIFT DOWN BELT CLIP 112
ST2
ST3
IS DETECTOR 202 TURNED ON?
NO
YES
ST4
DOES STACKER ACCOMMODATE A PLURALITY OF MEDIA?
NO
YES
ST5
HAS PULSE OF T1+T2 PASSED ?
NO
YES
ST6
HAS PULSE OF T1 PASSED ?
NO
YES
STOP DRIVING MOTOR 37
ST7
STOP LIFTING DOWN BELT CLIP 112
ST8
END

MEDIUM TRANSPORTING UNIT AND MEDIUM PROCESSING APPARATUS

Priority is claimed under 35 U.S.C. §120 to U.S. patent application Ser. No. 13/860,277, now U.S. Pat. No. 8,789,075, filed Apr. 10, 2013, and under 35 U.S.C. §119 to Japanese Patent Application No. 2007-099879 filed Apr. 5, 2007, which are hereby incorporated by reference in its entirety, including the specification, drawings and claims.

BACKGROUND

The present invention relates to a medium transporting unit that transports a plate-like medium such as a CD or a DVD and a medium processing apparatus having the medium transporting unit.

In recent years, medium processing apparatuses such as disc dubbing apparatuses that record data on mediums such as plural blank CDs or DVDs and CD/DVD publishers that can produce and publish a medium by performing a data recording operation and a label printing operation were used. Such a kind of medium processing apparatus was known which has a drive for driving data on a medium, a printer for performing a printing operation on a label surface of the medium, and a medium transporting unit for holding and transporting the medium to the drive or the printer (for example, see Patent Document 1).

Patent Document 1: Japanese Patent Publication No. 2006-202379A.

Blank mediums that have not been subjected to a recording process and the like are received and stacked in the medium stacker. Adjacent mediums in the stacker may be adhered to each other due to an adhesive force. Accordingly, at the time of picking up the uppermost medium, the medium just-below the uppermost medium (that is, the second medium) may be adhered and lifted up together with the uppermost medium.

When two mediums are transported in a state where they are adhered to each other, a problem may be caused in a drive to which the two mediums are transported. In addition, holding failure of the uppermost medium may easily occur.

SUMMARY

Accordingly, an object of at least one embodiment of the invention is to provide a medium transporting unit that can satisfactorily transport only a single medium to be held and a medium processing apparatus having the medium transporting unit.

In order to accomplish the above-mentioned object, according to an aspect of at least one embodiment of the invention, there is provided a medium transporting unit for transporting a top medium from a plurality of plate-shaped media accommodated in a stacker in a stacked manner, the medium transporting unit comprising: a holding mechanism operable to hold the top medium; and a transport arm provided with the holding mechanism, wherein the transport arm is provided with a separation mechanism operable to separate a second medium positioned just below the top medium which is held by the holding mechanism.

Accordingly, even when the second medium positioned just below the top medium is adhered to the top medium, it is possible to pick up and transport only the top medium without any holding failure by separating the second medium.

The separation mechanism may include a separation member having an operation piece which is movable so as to come in contact with an inner peripheral surface of a center hole formed on the second medium and being operable to move the operation piece to move the second medium in a radial direction thereof.

According to this configuration, by moving the separation member to allow the operation piece to protrude at the time of the holding and lifting up the top medium, it is possible to easily separate the second medium adhered to the top medium.

The medium transporting unit may further comprise a lift mechanism operable to lift up and down the transport arm.

The separation mechanism may include a moving mechanism operable to move the separation member so that the operation piece is located at a separation position where the operation piece comes in contact with the inner peripheral surface of the center hole to move the second medium in the radial direction thereof when the lift mechanism lifts up the transport arm and the operation piece is located at a waiting position where the operation piece does not come in contact with the inner peripheral surface of the center hole when the lift mechanism lifts down the transport arm.

According to this configuration, it is possible to separate the second medium by moving the separation member, without providing a specific driving mechanism.

The moving mechanism may include a rack extending in a vertical direction and a pinion engaging with the rack; and the moving mechanism may move the separation member by a rotational force of the pinion which is rotated by the rack when the lift mechanism lifts up and down the transport arm.

According to this configuration, it is possible to allow the operation piece to protrude and retract in the diameter direction by lifting up and down the transport arm to move the separation member.

The moving mechanism may include a clutch gear rotatable by a predetermined angle when the lift mechanism lifts up and down the transport arm.

According to this configuration, at the time of picking up the held top medium by lifting up the transport arm, the separation member is moved by a predetermined distance by the clutch gear rotated by a predetermined angle at the time of lifting up the transport arm and it is thus possible to separate the second medium by allowing the operation piece to protrude outwardly in the radial direction by a predetermined distance.

On the other hand, at the time of moving the transport arm so as to hold the medium or to place the held top medium at a predetermined position, the separation member is moved in the opposite direction by a predetermined distance by the clutch gear reversely rotated by a predetermined angle at the time of lifting down the transport arm, and it is thus possible to insert the operation piece, thereby preventing the operation piece from interfering with the medium to be held or the medium to be placed.

The separation member may include a front lever portion having the operation piece and a rear lever portion moved by the moving mechanism. Such a configuration is effective for making the very small operation piece movable.

The separation member may include an elastic member operable to transmit a moving force applied to the rear lever portion to the front lever portion so that the operation piece applies an acting force to the second medium; and when a counteracting force from the second medium is more than a force of the elastic member, the elastic member may deform so as not to transmit the moving force to the front lever portion. With this configuration, the operation piece is

prevented from being damaged before separating the second medium from the top medium due to the very strong adhesion therebetween.

According to another aspect of at least one embodiment of the invention, there is provided a medium processing apparatus comprising: the above medium transporting unit; and a media drive having at least one of a function for writing data on the transported medium which is transported by the medium transporting unit and a function for reading data on the transported medium.

With this configuration, it is possible to satisfactorily transport only a medium to be held, thereby enhancing the processing reliability of the medium processing apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and advantages of the present invention will become more apparent by describing in detail preferred exemplary embodiments thereof with reference to the accompanying drawings, wherein:

FIG. **1** is a perspective view illustrating an appearance of a publisher (medium processing apparatus);

FIG. **2** is a perspective view illustrating the front side of the publisher with a case removed from the publisher;

FIG. **3** is a perspective view illustrating the rear side of the publisher with the case removed from the publisher;

FIG. **4** is a perspective view illustrating a recording unit of the publisher;

FIG. **5** is a perspective view illustrating a medium transporting unit;

FIG. **6** is a perspective view illustrating a part of the medium transporting unit;

FIG. **7** is a perspective view illustrating a connection mechanism between a transport arm and a timing belt;

FIG. **8** is an enlarged perspective view illustrating the connection mechanism between the transport arm and the timing belt as viewed from the bottom;

FIG. **9** is a perspective view illustrating an internal structure of the transport arm;

FIG. **10** is a plan view illustrating the transport arm having held a medium as viewed from the bottom;

FIG. **11** is a sectional view illustrating a holding portion of the transport arm;

FIG. **12** is a perspective view illustrating a medium guide disposed in the holding portion of the transport arm;

FIG. **13** is a plan view illustrating the medium guide disposed in the holding portion of the transport arm;

FIG. **14** is a plan view of an arm base which is intended to explain a holding mechanism;

FIG. **15** is a perspective view illustrating holding claws of the holding mechanism;

FIG. **16** is an enlarged plan view illustrating the holding claws;

FIG. **17** is a plan view illustrating movements of pivoting plates and the holding claws;

FIG. **18** is a plan view illustrating movements of the pivoting plates and the holding claws;

FIG. **19** is a plan view illustrating movements of the pivoting plates and the holding claws;

FIG. **20** is a sectional view illustrating the holding claws;

FIG. **21** is a plan view of an arm base which is intended to explain a separation mechanism;

FIG. **22** is a front view illustrating the transport arm when the holding portion is viewed in a section;

FIG. **23** is a perspective view illustrating the separation mechanism;

FIG. **24** is a sectional view illustrating a pivoting mechanism disposed in the separation mechanism;

FIG. **25** is a plan view illustrating the pivoting mechanism disposed in the separation mechanism;

FIG. **26** is a plan view schematically illustrating the movement of the separation mechanism;

FIG. **27** is a plan view schematically illustrating the movement of the separation mechanism;

FIG. **28** is a graph illustrating a relation between a down stroke of a belt clip of the transport arm and a load acting on a medium; and

FIG. **29** is a flowchart illustrating a process of controlling a driving motor for lifting up and down the transport arm.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Hereinafter, a medium transporting unit according to an embodiment of the invention and a medium processing apparatus having the medium transporting unit will be described with reference to the drawings.

In this embodiment, the invention is applied to a medium processing apparatus including a publisher.

As shown in FIG. **1**, the publisher **1** is a medium processing apparatus for recording data on a disc-like medium such as CD or DVD or printing an image on a label surface of the medium and has a case **2** having a substantially rectangular hexahedral shape. Shutters **3** and **4** which can be opened and closed slidably in the lateral direction are attached to the front surface of the case **2**. An operation surface **5** having display lamps, operation buttons, and the like arranged thereon is disposed at the left-upper end portion of the case **2** and a medium discharge port **6** is disposed at the lower end of the case **2**.

The right shutter **3** as viewed from the front side is a door which is opened and closed at the time of setting a blank medium MA not used or taking out the completed medium MB (see FIG. **2**).

The left shutter **4** as viewed from the front side is opened and closed at the time of replacing an ink cartridge **12** of a label printer **11** (see FIG. **2**). By opening the shutter **4**, a cartridge mounting section **14** (see FIG. **2**) having plural cartridge holders **13** arranged in the vertical direction is exposed.

As shown in FIG. **2**, in the case **2** of the medium processing apparatus **1**, a blank medium stacker **21** as a medium storage unit in which plural blank mediums MA not yet used and not yet subjected to a data recording process can be stacked and a completed medium stacker **22** as a medium storage unit in which completed mediums MB are disposed vertically so that the center lines of the stored mediums are aligned with each other. The blank medium stacker **21** and the completed medium stacker **22** can be attached to and detached from predetermined positions shown in FIG. **2**.

The blank medium stacker **21** has a pair of arc-shaped frames **24** and **25**. Accordingly, the blank mediums MA can be received from the top and can be stacked coaxially in the stacker. The operation of receiving or replenishing the blank mediums MA in the blank medium stacker **21** can be simply performed by opening the shutter **3** and taking out the stacker.

The completed medium stacker **22** has the same structure and includes a pair of arc-shaped frames **27** and **28**. Accordingly, the completed mediums MB can be received from the top and can be stacked coaxially in the stacker.

The completed mediums MB (that is, mediums having been completely subjected to a data recording process and a label-surface printing process) may be taken out through the shutter **3**.

A medium transporting unit **31** is disposed in the back of the blank medium stacker **21** and the completed medium stacker **22**. In the medium transporting unit **31**, a chassis **32** is pivotably attached to a vertical guide shaft **35** vertically suspended between a base **72** and the top plate of the case **2** (see FIG. **5**). A fan-shaped final-stage gear **109** is fixed to a horizontal supporting plate **34** of the chassis **32** (see FIG. **5**). The transport arm **36** is supported by the chassis **32** so as to freely go up and down. The transport arm **36** can be lifted up and down along the vertical guide shaft **35** by a driving motor **37** which can be a step motor and can horizontally pivot about the vertical guide shaft **35**. A medium transported to the medium discharge port **6** by the medium transporting unit **31** can be taken out of the medium discharge port **6**.

Two medium drives **41** vertically stacked are disposed on a side of the upper and lower stackers **21** and **22** and the medium transporting unit **31**. A carriage **62** (see FIG. **4**) of a label printer **11** is movably disposed below the medium drives **41**.

The medium drives **41** have medium trays **41***a* that can move between a data recording position where data is recorded on a medium and a medium transferring position where the medium is transferred, respectively.

The label printer **11** has a medium tray **51** that can move between a printing position where an image is printed on a label surface of the medium and a medium transferring position where the medium is transferred (see FIG. **3**).

In FIGS. **2** and **3**, a state where the medium tray **41***a* of the upper medium drive **41** is drawn forward and located at the medium transferring position and a state where the medium tray **51** of the lower label printer **11** is located at the label printing position are shown. The label printer **11** is an ink jet printer and employs ink cartridges **12** of various colors (6 colors of black, cyan, magenta, yellow, light cyan, and light magenta in this embodiment) as the ink supply mechanism **71**. The ink cartridges **12** are mounted on the cartridge holders **13** of the cartridge mounting section **14** from the front side.

Here, a gap through which the transport arm **36** of the medium transporting unit **31** can be lifted up and down is formed between the pair of frames **24** and **25** of the blank medium stacker **21** and between the pair of frames **27** and **28** of the completed mediums stacker **22**. A clearance allowing the transport arm **36** of the medium transporting unit **31** to horizontally pivot and to be located just above the completed medium stacker **22** is opened between the blank medium stacker **21** and the completed medium stacker **22**. When the medium tray **41***a* is pushed into the medium drive **41**, the transport arm **36** of the medium transporting unit **31** can be lifted down to access the medium tray **51** located at the medium transfer position. Accordingly, it is possible to transport the mediums to the individual elements by combination of the lifting operation and the pivoting operation of the transport arm **36**.

A waste stacker **52** for storing waste mediums MD is disposed below the medium transfer position of the medium tray **51**. For example, about 30 waste mediums MD can be stored in the waste stacker **52**. In a state where the medium tray **51** retreats from the medium transfer position above the waste stacker **52** to the data recording position, the waste mediums MD can be supplied to the waste stacker **52** by the use of the transport arm **36** of the medium transporting unit **31**.

Due to the above-mentioned configuration, the transport arm **36** of the medium transporting unit **31** can transport a medium such as a CD or DVD among the blank medium stacker **21**, the completed medium stacker **22**, the waste stacker **52**, the medium tray **41***a* of the medium drive **41**, and the medium tray **51** of the label printer **11**.

As shown in FIG. **4**, the label printer **11** includes a carriage **62** having an ink jet head **61** with ink ejecting nozzles (not shown). The carriage **62** horizontally reciprocates along a carriage guide shaft **63** by means of the driving force of a carriage motor **65** (see FIG. **3**).

The label printer **11** includes an ink supply mechanism **71** having a cartridge mounting section **14** to be mounted with ink cartridges **12** (see FIG. **2**). The ink supply mechanism **71** has a vertical structure and is formed upright in the vertical direction on a base **72** of the publisher **1**. An end of a flexible ink supply tube **73** is connected to the ink supply mechanism **71** and the other end of the ink supply tube **73** is connected to the carriage **62** (see FIG. **4**).

The ink of the ink cartridges **12** mounted on the ink supply mechanism **71** is supplied to the carriage **62** through the ink supply tube **73**, is supplied to the ink jet head **61** through a damper unit and a pressure distribution control unit (not shown) disposed in the carriage **62**, and then is ejected from the ink nozzles (not shown).

A pressurizing mechanism **74** is disposed in the ink supply mechanism **71** so as to put the main portion is above the ink supply mechanism. The pressurizing mechanism **74** pressurizes the ink cartridges **12** by blowing out compressed air, thereby sending out the ink stored in ink packs of the ink cartridges **12**.

A head maintenance mechanism **81** is disposed below the home position (position shown in FIG. **4**) of the carriage **62**.

The head maintenance mechanism **81** includes a head cap **82** covering the ink nozzles of the ink jet head **61** exposed from the bottom surface of the carriage **62** located at the home position and a waste ink suction pump **83** sucking the ink discharged to the head cap **82** due to a head cleaning operation or an ink filling operation of the ink jet head **61**.

The ink sucked by the waste ink suction pump **83** of the head maintenance mechanism **81** is sent to a waste ink tank **85** through a tube **84**.

In the waste ink tank **85**, an absorbing material is disposed in a case **86** and the top surface is covered with a cover **88** having plural ventholes **87**.

A waste ink receiver **89** as a part of the waste ink tank **85** is disposed below the head maintenance mechanism **81** and receives the ink from the head maintenance mechanism **81**. Then, the ink is absorbed by the absorbing material.

As shown in FIG. **5**, in the medium transporting unit **31**, the horizontal supporting plate **34** and the top plate **33** of the cassis **32** is supported by the vertical guide shaft **35** disposed in the vertical direction. Here, the chassis **32** is pivotable. The transport arm **36** is supported by the chassis **32** so as to be lifted up and down.

As shown in FIG. **6**, the lift mechanism of the transport arm **36** includes a lifting driving motor (lift mechanism) **37** as a driving source, which employs a pulse motor in this embodiment. The rotation of the driving motor **37** is transmitted to a driving pulley **101** through a pinion **97** and a transmission gear **98** fitted to an output shaft of the driving motor **37**. The driving pulley **101** is supported to be rotatable about a horizontal rotation shaft in the vicinity of the top end of the chassis **32**. A driven pulley **103** is supported to be

rotatable about the horizontal rotation shaft in the vicinity of the bottom end of the chassis **32**. A timing belt (lift mechanism) **104** is suspended on the driving pulley **101** and the driven pulley **103**. As shown in FIG. **7**, a base **110** of the transport arm **36** is connected to one horizontal end of the timing belt **104** through a belt clip (lift member) **112**.

Accordingly, when the driving motor **37** is activated, the timing belt **104** moves in the vertical direction and the transport arm **36** attached thereto is thus lifted up and down along the vertical guide shaft **35**. A sensor not shown for detecting the home position of the timing belt **104** is attached to the chassis **32**.

As shown in FIG. **5**, a rotation mechanism of the transport arm **36** includes a rotational driving motor **105** as a driving source and a pinion (not shown) is fitted to the output shaft of the driving motor **105**. The rotation of the pinion is transmitted to the fan-shaped final-stage gear **109** through a reduction gear train having a transmission gear **107**. The fan-shaped final-stage gear **109** can rotate horizontally about the vertical guide shaft **35**. The final-stage gear **109** is mounted to the chassis **32** having constituent elements of the lift mechanism for the transport arm **36**. When the driving motor **105** is activated, the fan-shaped final-stage gear **109** rotates horizontally and thus the chassis **32** mounted thereon monolithically rotates horizontally about the vertical guide shaft **35**. As a result, the transport arm **36** retained by the lift mechanism mounted on the chassis **32** rotates horizontally about the vertical guide shaft **35**. A sensor not shown for detecting the home position (a position just above the medium trays **41***a* and **51** where the transport arm **36** is located at the medium transfer position) of the final-stage gear **109** and positions just above the blank medium stacker **21** and the completed medium stacker **22** is fitted to the base **72**.

Next, a supporting structure of the transport arm **36** will be described.

As shown in FIGS. **7** and **8**, a sliding shaft (support portion) **111** is vertically disposed on the base **110** of the transport arm **36**. The sliding shaft **111** is inserted through a shaft hole **112***a* of the belt clip **112** fixed by holding the timing belt **104** (see FIG. **7**) so as to be slidable from the upside. In FIG. **8**, the timing belt **104** is omitted.

A locking piece **112***b* is formed in the belt clip **112**. An end of a first tension spring (first elastic urging means **113**) which is a coil spring is connected to the locking piece **112***b*. The other end of the first tension spring **113** is connected to a fixed piece **115** formed in the base **110** of the transport arm **36** and disposed above the locking piece **112***b*. Accordingly, the base **110** of the transport arm **36** is urged downward by the first tension spring **113**.

A fixing portion **112***c* for fixing the timing belt **104** therebetween is formed in the belt clip **112**.

A pressing lever **116** attached to the base **110** of the transport arm **36** is disposed below the belt clip **112**. The pressing lever **116** is laterally inserted through an insertion hole **118** formed in a supporting plate **117** disposed on the bottom of the base **110** of the transport arm **36** and is pivotable about a supporting point in the supporting plate **117**. An end of a second tension spring (second elastic urging means) **119** formed of a coil spring having an urging force greater than that of the first tension spring **113** is connected to an end of the pressing lever **116** and the other end of the second tension spring **119** is connected to a fixed piece **120** that is formed in the base and disposed above the end of the pressing lever **116**. Accordingly, the end of the pressing lever **116** is urged upward by the second tension spring **119**. A pivot regulating piece **121** formed on the base **110** is disposed above the vicinity of the end of the pressing lever **116** and the pivot of the pressing lever **116** urged upward by the second tension spring **119** is regulated to a predetermined position. The belt clip **112** is disposed at a position apart from the pressing lever **116** regulated by the pivot regulating piece **121**, by clearance S.

In the above-mentioned supporting structure, when the timing belt **104** is driven by the lifting driving motor **37** (see FIG. **5**), the transport arm **36** is lifted up and down monolithically with the belt clip **112** fixed to the timing belt **104**. When a medium guide **133** to be described later or a holding mechanism **130** comes in contact with the medium and a down load of the transport arm **36** increases, only the belt clip **112** moves down against the urging force of the first tension spring **113** relative to the transport arm **36**. When the belt clip **112** further moves down by means of the timing belt **104**, the belt clip **112** comes in contact with the pressing lever **116**, the transport arm **36** is slightly bent, and then the pressing lever **116** pivots about a support point in the supporting plate **117** against the urging force of the second tension spring **119**.

Next, inner mechanisms of the transport arm **36** will be described.

As shown in FIG. **9**, the transport arm **36** includes a longitudinal arm base **125***a* having a rectangular shape in the plan view and an arm case **125***b* having the same profile as the arm base **125***a* so as to cover the arm base. The arm base **125***a* is provided with a holding mechanism **130** for holding a medium M, a separation mechanism **131**, and a medium detecting mechanism **200**. The holding mechanism **130**, the separation mechanism **131**, and the medium detecting mechanism **200** are covered with the arm case **125***b*.

As shown in FIGS. **10** and **11**, a bottom portion in the vicinity of the end of the arm base **125***a* serves as the holding portion **132** for holding a medium M. The medium guide **133** is disposed in the holding portion **132**.

As shown in FIGS. **12** and **13**, the center of the medium guide **133** corresponds to the pickup center of the medium M and the medium guide has a guide portion **135** protruding downward at the center of a fixed portion **134** fixed to the bottom surface of the arm base **125***a*. The guide portion **135** has a cylindrical base end **135***a* formed with a diameter slightly smaller than that of the center hole Ma of the medium M and a guide surface **135***b* formed in a cone shape that points downward from the base end **135***a*. The medium guide **133** is inserted into the center hole Ma of the medium M by approaching the medium M, the inner circumferential surface Mb of the center hole Ma of the medium m is guided by the guide surface **135***b*, the center position of the medium M is aligned with the center position of the medium guide **133** by the guide surface **135***b*, and then the center hole Ma of the medium M is guided by the base end **135***a*, whereby the base end **135***a* is inserted through the center hole of the medium M.

Three window portions **133***a* are formed in the medium guide **133**. Three holding claws **141** to **143** of the holding mechanism **130** and an operation piece **183** of the pressing lever **182** of the separation mechanism **131** can protrude and retreat into and from the window portions **133***a*.

As shown in FIGS. **12** and **13**, the holding mechanism **130** has three cylindrical holding claws **141** to **143** which are disposed at an approximate equiangular interval (120°) on the same circle. The holding claws **141** to **143** protrudes vertically downward from circular hole **125***c* formed in the arm base **125***a* and are disposed inside the window portions **133***a* of the medium guide **133**. The three holding claws **141** to **143** are inserted into the center hole Ma of the medium,

guided to the base end **135***a* of the medium guide **133**, then are made to move outward, and are made to protrude from the window portions **133***a* of the medium guide **133**, thereby pressing the inner circumferential surface Mb of the center hole Ma of the medium M to hold the medium M.

As shown in FIG. **20**, the holding claws **141** to **143** are attached to lower ends of supporting pins **151** to **153** having a diameter greater than the holding claws. The supporting pins **151** to **153** extend upwardly through the circular hole **125***c* of the arm base **125***a* and three pivoting plates **161** to **163** disposed on the top surface of the arm base **125***a*. Pivoting center axes **171** to **173** are vertically fixed to the arm base **125***a* at the equiangular interval on the same circle so as to surround the circular hole **125***c*. The pivoting plates **161** to **163** are supported to be pivotable about the pivoting center axes **171** to **173**, respectively.

As shown in FIGS. **14** to **16**, each pivoting plate **161** to **163** includes a front arm portion **161***a* to **163***a* extending counterclockwise in the top view, a rear arm portion **161***b* to **163***b* extending clockwise in the top view, and supporting arms **161***c* to **163***c* protruding inside the center hole **125***c* from the pivoting center, along the arm base **125***a* from the pivoting center axis **171** to **173**. The supporting pins **151** to **153** are vertically formed on the rear surface of the ends of the supporting arms **161***c* to **163***c*, respectively.

A longitudinal hole **161***d* in a direction substantially perpendicular to the circular hole **125***c* is formed in the rear arm portion **161***b* of the pivoting plate **161**. A slide pin **163***f* protruding downward from the rear end of the front arm portion **163***a* of the pivoting plate **163** is slidably inserted through the longitudinal hole **161***d*.

A slide surface **163***e* (see FIG. **16**) in a direction substantially perpendicular to the circular hole **125***c* is formed at the end of the rear arm portion **163***b* of the pivoting plate **163** and the front end of the front arm portion **162***a* of the pivoting plate **162** is established so as not to come in contact with the slide surface **163***e*. A slide surface **162***e* in the direction substantially perpendicular to the circular hole **125***c* is formed at the end of the rear arm portion **162***b* of the pivoting plate **162** and the front end of the front arm portion **161***a* of the pivoting plate **161** is in sliding contact with the slide surface **162***e*. Here, the longitudinal hole **161***d* of the pivoting plate **161** and the slide surfaces **162***e* and **163***e* of the pivoting plates **162** and **163** are formed in a concave curved shape set to allow the pivoting plates **161** to **163** to pivot the in same direction.

Tension coil springs (urging members) **174** are suspended between the rear arm portion **161***b* of the pivoting plate **161** and the rear arm portion **162***b* of the pivoting plate **162**, between the rear arm portion **162***b* of the pivoting plate **162** and the rear arm portion **163***b* of the pivoting plate **163**, and between the rear arm portion **163***b* of the pivoting plate **163** and the rear arm portion **161***b* of the pivoting plate **161**. By means of the tension of the tension coil springs **174**, the pivoting plates **161** to **163** are supported without pivoting independently and the urging force, in the direction indicated by arrow R**1** in FIG. **16**, that is, in the direction in which the holding claws **141** to **143** move outward, is applied to the pivoting plates **161** to **163**.

In the state shown in FIG. **16**, the circumscribed circle of the holding claws **141** to **143** attached to the ends of the supporting arms **161***c* to **163***c* of the pivoting arms **161** to **163** has a diameter greater than the inner diameter of the center hole Ma of the medium M. In this state, when pivoting plate **161** is made to pivot in the direction indicated by arrow R**2**, the other pivoting plates **162** and **163** accordingly pivot in the same direction as indicated by arrow R**2**. As a result, the supporting arms **161***c* to **163***c* of the pivoting plates **161** to **163** move to the center of the circular hole **125***c* and the holding claws **141** to **143** attached to the ends move inward so that they can be inserted into the center hole Ma of the medium M.

In this state, when the holding claws **141** to **143** are inserted into the center hole Ma of the Medium and then the pivoting plates **161** to **163** are made to pivot in the opposite direction R**1**, the holding claws **141** to **143** move outward in the radius direction. As a result, the holding claws **141** to **143** are pressed on the inner circumferential surface Mb of the center hole of the medium M, thereby holding the medium M.

As shown in FIG. **14**, an operation arm **161***g* extending to the opposite side of the supporting arm **161***c* is formed in the pivoting plate **161**. The end of one arm portion **175***a* of a link **175** is rotatably connected to the end of the operation arm **161***g*. The link **175** is supported by the arm base **125***a* so as to be rotatable about a middle portion thereof and the end of the opposite arm portion **175***b* is connected to an operation rod **176***a* of an electromagnetic solenoid **176**. When the electromagnetic solenoid **176** is turned off, the operation rod **176***a* protrudes by action of the spring force of a built-in spring.

In this state, where the electromagnetic solenoid **176** is turned on, the operation rod **176***a* is reversely inserted against the spring force in the electromagnetic solenoid, the link **175** pivots clockwise, and the pivoting plate **161** thus pivots in the direction of R**2**. Then, as shown in FIG. **17**, the slide surface **162***e* of the rear arm portion **162***b* of the pivoting plate **162** comes in sliding contact with the end of the front arm portion **161***a* of the pivoting plate **161** and the inner surface of the longitudinal hole **161***d* of the rear arm portion **161***b* of the pivoting plate **161** comes in sliding contact with the slide pin **163***f* of the front arm portion **163***a* of the pivoting plate **163**. Accordingly, the slide surface **162***e* of the pivoting plate **162** comes in sliding contact with the end of the front arm portion **161***a* of the pivoting plate **161** and slides outward in the diameter direction of the circular hole **125***c*, whereby the pivoting plate **162** pivots in the direction of R**2**. The inner surface of the longitudinal hole **161***d* of the rear arm portion **161***b* of the pivoting plate **161** comes in sliding contact with the slide pin **163***f* of the front arm portion **163***a* of the pivoting plate **163** and thus the front arm portion **163***a* of the pivoting plate **163** slides toward the center of the circular hole **125***c*, whereby the pivoting plate **163** also pivots in the direction of R**2**.

In this way, when the pivoting plate **161** pivots in the direction of R**2**, the pivoting force in the direction of R**2** of the pivoting plate **161** is transmitted to the other pivoting plates **162** and **163** and thus the pivoting plates **162** and **163** also pivot in the direction of R**2**, as shown in FIG. **18**. The holding claws **141** to **143** disposed in the supporting arms **161***c* to **163***c* of the pivoting plates **161** to **163** are disposed in the circumscribed circle sufficiently smaller than the center hole Ma of the medium M and move inward until it can be inserted into the center hole Ma of the medium M.

In this state, when the electromagnetic solenoid **176** is turned off, the operation rod **176***a* is made to protrude by means of the spring force of the spring in the electromagnetic solenoid and the tension coil spring **174** and the link **175** thus pivots. Then, the pivoting motion of the link **175** is transmitted to the pivoting plate **161** and thus the pivoting plate **161** pivots in the direction of R**1**. Accordingly, in the other pivoting plates **162** and **163**, the rear arm portions **162***b* and **163***b* move toward the center of the circular hole **125***c* by means of the tension of the tension coil spring **174**

and thus the pivoting plates **162** and **163** also pivot in the direction of R1 like the pivoting plate **161**. As a result, as shown in FIG. **19**, the holding claws **141** to **143** move outward and the holding claws **141** to **143** are pressed on the inner circumferential surface Mb of the center hole Ma of the medium M, thereby holding the medium M.

At this time, since the pivoting plates **162** and **163** pivot in the direction of R1 by means of the tension of the tension coil spring **174** independently of the pivoting plate **161**, the holding claws **141** to **143** move outward in the radius direction independently of each other and thus are pressed on the inner circumferential surface Mb of the center hole Ma of the medium M.

As shown in FIG. **20**, each of three holding claws **141** to **143** includes a cylindrical pin **141***a* to **143***a* protruding form the bottom end of the supporting pin **151** to **153** and an elastic cylinder **141***b* to **143***b* made of rubber to surround the pin **141***a* to **143***a* concentrically. Here, although the cylindrical pin **142***a* and the elastic cylinder **142***b* are not shown in FIG. **20**, these components are provided with the holding claw **142** in a similar configuration as the holding claws **141** and **143**. In the holding claws **141** to **143**, the downward protruding length l is equal to or smaller than the thickness t**1** of the medium M to be held. It is preferable that the producing length l is equal to or greater than the thickness t**2** of the inner circumferential surface Mb of the center hole Ma of the medium M and equal to or smaller than the thickness t**1** of the medium M including the height of a ring-shaped protrusion Mc. Accordingly, when the mediums M stacked in the thickness direction are held, the holding claws **141** to **143** hold only the uppermost medium M without coming in contact with the inner circumferential surface Mb of the second medium M. The portions of the supporting pins **151** to **153** close to the holding claws **141** to **143** are contact surfaces **151***a* to **151***b* with the medium Mm to be held.

As shown in FIGS. **21** to **23**, the separation mechanism **131** disposed in the arm base **125***a* of the transport arm **36** includes a pressing lever **182** that is rotatably supported by a support shaft **181** formed in the arm base **125***a*. The pressing lever **182** includes two components of a front lever portion **182***a* on the holding side and a rear lever portion **182***b* on the rotation side. In the front lever portion **182***a*, a cylindrical bearing portion **184** inserted through the support shaft **181** formed in the arm base **125***a* is made to protrude upward and the rear lever portion **182***b* is pivotably supported by the bearing portion **184**. The front lever portion **182***a* and the rear lever portion **182***b* are pivotable in a predetermined range by a locking portion **185** which is prevented from being separated from the front lever portion **182***a* and an opening **186** having a width greater than the width of the locking portion **185** and being disposed in the rear lever portion **182***b*. As shown in FIGS. **23** and **26**, the front lever portion **182***a* and the rear lever portion **182***b* are urged in a direction by a buffer spring **187** which is a twist coil spring. Specifically speaking, in the buffer spring **187** attached to the outer circumference of the pivoting portion of the rear lever portion **182***b*, one arm portion **187***a* urges a receiving portion **182***d* of the front lever portion **182***a* and the other arm portion **187***b* urges a receiving portion **182***e* of the rear lever portion **182***b* so as to be apart from each other. Accordingly, in the pressing lever **182**, a great load is applied to an operation piece **183** to be described later when the rear lever portion **182***b* allows the front lever portion **182***a* to pivot, and the buffer spring **187** is bent when the front lever portion **182***a* cannot pivot, thereby preventing the damage of the operation piece **183**. The front lever portion **182***a* has the operation piece **183** bent from the front end to the down side and laterally bent in an L shape. The operation piece **183** is disposed in the medium guide **133** of the holding portion **132**.

In a state where the holding claws **141** to **143** of the holding portion **132** hold the medium M, the operation piece **183** of the pressing lever **182** is disposed horizontal below the medium M. Specifically, the operation piece is disposed at a position corresponding to the second medium M of the mediums stacked in the thickness direction.

When the pressing lever **182** pivots at the connection point **181** in the direction of R3 in FIG. **21**, the operation piece **183** protrudes laterally from the window portion **133***a* of the medium guide **133** and comes in pressing contact with the inner circumferential surface Mb of the center hole Ma of the second medium M just below the uppermost medium M held by the holding claws **141** to **143**. When the pressing lever **182** pivots in the opposite direction of R4 in this state, the operation piece **183** is inserted into the medium guide **133**.

A pivot mechanism **190** for allowing the pressing lever **182** to pivot is disposed in the rear lever portion **182***b* of the pressing lever **182**. The pivot mechanism **190** includes a complex clutch gear **191**, a vertical complex transmission gear **192**, a horizontal complex transmission gear **193**, and a lock **194**.

As shown in FIG. **5**, the lock **194** is vertically supported by the chassis **32** constituting the medium transporting unit **31** so as to be parallel to the vertical guide shaft **35**. The lock **194** engages with a pinion **193***b* of the horizontal complex transmission gear **193** supported by the arm base **125***a* so as to be rotatable about a horizontal shaft **193***a* (see FIG. **23**). By lifting up and down the transport arm **36**, the horizontal complex transmission gear **193**, which has the pinion **193***b* that engages with the lock **194**, rotates.

A screw gear **193***c* is disposed in the horizontal complex transmission gear **193**. The screw gear **193***c* engages with a screw gear **192***b* of the vertical complex transmission gear **192** supported by the arm base **125***a* so as to be rotatable about a vertical shaft **192***a*. Accordingly, when the horizontal complex transmission gear **193** rotates, the rotation of the horizontal complex transmission gear **193** having the horizontal shaft **193***a* is transmitted to the vertical complex transmission gear **192** having the vertical shaft **192***a* through the screw gears **192***b* and **193***c* engaging with each other, thereby allowing the vertical complex transmission gear **192** to rotate.

The vertical complex transmission gear **192** includes a horizontal gear **192***c*. The horizontal gear **192***c* engages with a horizontal gear **191***b* of the complex clutch gear **191** supported by the arm base **125***a* so as to be rotatable about the vertical shaft **191***a*. Accordingly, when the vertical complex transmission gear **192** rotates, the rotating force of the vertical complex transmission gear **192** is transmitted to the complex clutch gear **191** through the horizontal gears **191***b* and **192***c* engaging with each other, thereby allowing the complex clutch gear **191** to rotate.

As shown in FIGS. **24** and **25**, the complex clutch gear **191** includes an intermittent gear **191***c* that is rotatable relative to the horizontal gear **191***b*. A clutch mechanism **195** is disposed between the horizontal gear **191***b* and the intermittent gear **191***c*. The horizontal gear **191***b* has a cylinder shaft **191***d* through which the shaft **191***a* is inserted. The cylinder shaft **191***d* is inserted through a cylinder shaft **191***e* formed in the intermittent gear **191***c*.

As shown in FIG. **25**, the intermittent gear **191***c* has a gear train **196** including plural gears **196***a* on a part of the

circumferential surface. The gear train **196** can engage with the horizontal gear **192***c* of the vertical complex transmission gear **192**.

The clutch mechanism **195** disposed in the complex clutch gear **191** has a twist coil spring **197** wound on the cylinder shaft **191***e* of the intermittent gear **191***c*. When the horizontal gear **191***b* is made to rotate in the counterclockwise direction of R**5** as viewed from the upside in FIG. **25** by the horizontal gear **192***c* of the vertical complex transmission gear **192**, the intermittent gear **191***c* is made to rotate with the horizontal gear **191***b* by the frictional force generated from the twist coil spring **197**. Accordingly, the gear train **196** engages with the horizontal gear **192***c* of the vertical complex transmission gear **192** and thus the intermittent gear **191***c* rotates in the direction of R**5** along with the horizontal gear **191***b*. On the contrary, when the horizontal gear **191***b* is made to rotate in the clockwise direction of R**6** as viewed from the upside in FIG. **25** by the horizontal gear **192***c* of the vertical complex transmission gear **192**, the intermittent gear **191***c* is made to rotate along with the horizontal gear **191***b* by means of the frictional force generated from the twist coil spring **197**. Accordingly, the gear train **196** engages with the horizontal gear **192***c* of the vertical complex transmission gear **192** and thus the intermittent gear **191***c* rotates in the direction of R**6** along with the horizontal gear **191***b*.

A cam hole **198** is formed in the intermittent gear **191***c*. A cam pin **182***c* protruding downward from the vicinity of the rear end of the rear lever portion **182***b* of the pressing lever **182** is slidably disposed in the cam hole **198**. The cam hole **198** has a path changing from the center to the outer circumference in the clockwise direction in the top view. Accordingly, when the intermittent gear **191***c* rotates in the counterclockwise direction of R**5** in the top view in the state shown in FIG. **26**, the cam pin **182***c* in the cam hole **198** is displaced to the outer circumference. Accordingly, as shown in FIG. **27**, the pressing lever **182** pivots in the direction of R**3** about a connection point **181** and thus the operation piece **183** protrudes to the outside of the medium guide **133**. In this state, when the intermittent gear **191***c* rotates in the clockwise direction of R**6** in the top view, the cam pin **182***c* in the cam hole **198** is displaced to the inner circumference. Accordingly, as shown in FIG. **26**, the pressing lever **182** pivots about the connection point **181** in the direction of R**4** and thus the operation piece **183** is inserted into the medium guide **133**.

In the separation mechanism **131** having the above-mentioned configuration, when the transport arm **36** starts going up, the complex clutch gear **191** starts rotating in the direction of R**5**. When the transport arm **36** further goes up and the complex clutch gear **191** rotates by a predetermined angle (about 45 degrees) from the state shown in FIG. **26** to the state shown in FIG. **27**, the pressing lever **182** pivots in the direction of R**3** (see FIG. **21**) and thus the operation piece **183** of the pressing lever **182** separates the second medium M in the meantime. When the transport arm **36** goes down, the complex clutch gear **191** rotates in the direction of R**6**. Accordingly, the pressing lever **182** rotates in the direction of R**4** (see FIG. **21**) and the operation piece **183** is inserted into the medium guide **133** as shown in FIG. **26**. Even when the transport arm **36** goes down in this state, the gear train **196** runs off from the horizontal gear **192***c* after the intermittent gear **191***c* of the complex clutch gear **191** rotates by a predetermined angle (about 45 degrees) in the direction of R**6** (see FIG. **26**) by the horizontal gear **192***c* of the vertical complex transmission gear **192** and thus the intermittent gear idly rotates relative to the horizontal gear **191***b*.

As shown in FIG. **9**, the medium detecting mechanism **200** includes a detection lever **201** of which the rear end is pivotably supported and the front end is bent downward to protrude toward the bottom surface of the arm base **125***a* and a detector **202** disposed aside the detection lever **201**. In the medium detecting mechanism **200**, when the transport arm **36** goes down to bring the top surface of the medium M into contact with the detection lever **201** and thus the detection lever **201** pivots upward to allow the detection lever **201** to depart from the detection area of the detector **202**, the detector **202** is turned on and thus it is possible to detect an approaching state to the medium M from the detection signal output from the detector **202**.

Next, an operation of picking up a medium M in the medium transporting unit **31** having the above-mentioned configuration will be described.

An example where the uppermost medium M of the mediums M stacked is held and picked up from the blank medium stacker **21** will be described with reference to the flowchart of controlling the lifting driving motor of the transport arm, which is shown in FIG. **29**.

First, in a state where the transport arm **36** is located at a predetermined height position just above the blank medium stacker **21**, the electromagnetic solenoid **176** of the holding mechanism **130** is turned on. In this state, the operation rod **176***a* of the electromagnetic solenoid **176** is inserted against the built-in spring, this movement is transmitted to the pivoting plate **161** through the link **175**, and the pivoting plate **161** pivots in the direction of R**2** in FIG. **16**. Accordingly, the other pivoting plates **162** and **163** pivot in the same direction and the holding claws **141** to **143** attached to the ends of the supporting arms **161***c* to **163***c* of three pivoting plates **161** to **163** moves close to each other, whereby it gets pointed so as to be inserted into the center hole Ma of the medium M.

Thereafter, the lifting driving motor **37** of the transport arm **36** is driven (ST**1**) and the belt clip **112** fixed to the timing belt **104** goes down (ST**2**), thereby starting the lift-down operation of the transport arm **36**. When the transport arm **36** is lifted down and gets close to the uppermost medium M, the medium guide **133** of the holding portion **132** is inserted into the center hole Ma of the medium M. Here, even when the center of the medium M in the blank medium stacker **21** runs off from the center of the holding portion **132**, the inner circumferential surface Mb of the center hole Ma of the medium M comes in contact with the conical guide surface **135***b*, the center position of the medium M is thus aligned with the center position of the medium guide **133** by the guide surface **135***b*, the center hole Ma of the medium M is guided to the base end **135***a*, and thus the base end **135***a* is inserted through the center hole Ma of the medium M. That is, the center of the medium M to be held is positioned at the center of the holding portion **132** which is the pickup center.

At this time, when the end of the detection lever **201** of the medium detecting mechanism **200** mounted on the transport arm **36** comes in contact with the surface of the medium M, the detection lever **201** pivots upward with the lift-down of the transport arm **36** and the detection lever **201** runs off from the detection area of the detector **202**, thereby turning on the detector **202** (ST**3**) to detect the access state to the medium M. It is determined whether the destination of the transport arm **36** is the blank medium stacker **21** receiving plural mediums stacked therein or the medium tray **51** or the medium tray **41***a* receiving a single medium (ST**4**). When the destination is the medium trays **41***a* and **51** of the drive and the printer, the driving motor is driven separately

(ST5) by adding pulse T2 to pulse T1 applied to the driving motor **37**, the driving motor is stopped (ST7) by lifting down the transport arm **36** by a predetermined distance, and the holding claws **141** to **143** of the holding mechanism **130** mounted on the transport arm **36** are inserted into the center hole Ma of the medium M.

The mediums M are stacked in the blank medium stacker **21**. Since the stacked mediums M are in close contact with each other, an adhesive force may occur between the mediums M.

Accordingly, when the second medium M is adhered to the uppermost medium M, it is difficult to horizontally position the uppermost medium only by bringing the holding claws **141** to **143** into contact with the inner circumferential surface Mb of the center hole Ma of the medium.

Accordingly, in the medium transporting unit **31**, by applying a predetermined pressing force to the uppermost medium M from the top, the pressing force toward the lateral end of the medium M is applied by the guide surface **135***b* of the medium guide **133**, thereby satisfactorily moving and positioning the medium M laterally.

A relation between a position of the belt clip **112** of the transport arm **36** and a load on the medium M will be described.

FIG. **28** is a graph illustrating a relation between a down stroke of the belt clip of the transport arm and a load on the medium.

First, in a state where the holding portion of the transport arm **36** is in contact with the uppermost medium M (a state between A and B in FIG. **28**), when the driving motor **37** continues driving by further applying pulse T2 (ST5), the belt clip **112** fixed to the timing belt **104** is lifted down against the urging force of the first tension spring **113** having a small spring force, the belt clip **112** goes down by a distance corresponding to the clearance S, and then the belt clip **112** comes in contact with the pressing lever **116** (state B in FIG. **28**). Accordingly, until the belt clip **112** comes in contact with the pressing lever **116** after the holding portion **132** comes in contact with the uppermost medium, the first elastic pressing force including the urging force of the first tension spring **113** having the small spring force is applied to the uppermost medium M (state between A and B in FIG. **28**).

When the driving motor **37** is further driven, the belt clip **112** further goes down. At this time, since the belt clip **112** is in contact with the pressing lever **116**, the lift-down force of the belt clip **112** is transmitted to the transport arm **36** to bend the transporting arm **36** and the bending force is applied as a pressing force to the uppermost medium M (state between B and C in FIG. **28**).

When the driving motor **37** is further driven (ST5), the belt clip **112** goes down and stops (ST7 and ST8), and thus the bending force of the transport arm **36** is greater than the urging force of the second tension spring **119** having a great spring force (state C in FIG. **28**), the pressing lever **116** pivots about a supporting point on the supporting plate **117** against the urging force of the second tension spring **119**. Accordingly, the second elastic pressing force obtained by adding the urging force of the second tension spring **119** to the urging force of the first tension spring **113** and the bending force of the transport arm **36** is applied to the uppermost medium M (states between C and E in FIG. **28**).

In the medium transporting unit **31** having the above-mentioned load characteristic, the driving motor **37** is stopped at a proper position (for example, position of D in FIG. **28**) in the state where the pressing force obtained by adding the urging force of the second tension spring **119** to the urging force of the first tension spring **113** and the bending force of the transport arm **36** is applied to the medium M (state between C and E in FIG. **28**).

As a result, among the stacked mediums M in the blank medium stacker **21**, a proper load (about 10 N) can be applied to the uppermost medium M. Accordingly, regardless of the adhesion to the second medium M, it is possible to satisfactorily move laterally and position the medium M by the use of the guide surface **135***b* of the medium guide **133**.

Even when the center position of the medium M runs off, it is possible to satisfactorily insert the medium guide **133** into the center hole Ma of the medium and to position the medium, by applying a load.

When the rigidity of the transport arm **36** is enhanced and the spring constant of the second tension spring **119** is increased, it is possible to obtain a necessary load by reducing the stroke of the belt clip **112** for generating the bending force of the transport arm **36** (state between B and C in FIG. **28**).

When the medium M is lifted up from the medium trays **41***a* and **51** of the medium drive **41** and the label printer **11** including only a single medium M, ST6 is performed as the determination result whether the destination of the transport arm **36** is the blank medium stacker **21** or the medium tray **51** of the medium tray **41***a* receiving a single medium (ST4) and only pulse T1 is thus applied to the driving motor **37** (ST6).

In this case, the driving motor is stopped in the region (clearance S in FIG. **7**) where the belt clip **112** fixed to the timing belt **104** is lifted down against the urging force of the first tension spring **113** having a small spring force. The medium M can be held by the use of the holding mechanism **130** in the state (state between A and B in FIG. **28**) where the first elastic pressing force including the urging force of the first tension spring **113** having a small spring force is applied until the belt clip **112** comes in contact with the pressing lever **116** after the holding portion of the transport arm **36** comes in contact with the medium M. As a result, since the load applied on the medium trays **41***a* and **51** at the time of tacking out the medium M can be reduced as much as possible, it is possible to suppress the overload due to the load on the medium trays **41***a* and **51**.

In this way, in a state where the second elastic pressing force is applied to the uppermost medium M in the blank medium stacker **21**, the holding claws **141** to **143** inserted into the center hole Ma of the medium M are made to move outward and are pressed on the inner circumferential surface Mb of the center hole Ma.

Specifically, first, when the electromagnetic solenoid **176** is turned off and the operation rod **176***a* thereof is made to protrude by action of the spring force, the pivoting plate **161** connected to the operation rod **176***a* through the link **175** pivots in the direction of R1. Accordingly, the other pivoting plates **162** and **163** pivot in the direction of R1 by means of the tension of the tension coil spring **174**, similarly to the pivoting plate **161**. As a result, the holding claws **141** to **143** move outward and the holding claws **141** to **143** are pressed on the inner circumferential surface Mb of the center hole of the medium M, thereby holding the medium M.

At this time, since the pivoting plates **162** and **163** pivot in the direction of R1 by means of the tension of the tension coil spring **174** independently of the pivoting plate **161**, the holding claws **141** to **143** also move outward in the radius direction independently of each other and are pressed on the inner circumferential surface Mb of the center hole Ma of the medium M.

Therefore, even when the center position of the uppermost medium M runs off from the pickup center, the holding claws **141** to **143** move outward independently and thus all the holding claws **141** to **143** come in contact with the inner circumferential surface Mb of the center hole Ma of the medium M, thereby satisfactorily preventing holding failure and the like.

In addition, the downward protruding length of the holding claws **141** to **143** is equal to or less than the thickness of the medium to be held. Accordingly, even when the center position of the second medium M runs off from that of the uppermost medium M, it is possible to prevent such a problem that the holding claws **141** to **143** come in contact with the edge of the center hole Ma of the second medium M to cause the holding failure.

When the medium M is held in this way, the held medium M is lifted up by lifting up the transport arm **36** in the state where the holding claws **141** to **143** move outward in the diameter direction. At this time, since the held uppermost medium M is satisfactorily held by all the holding claws **141** to **143**, it is possible to smoothly pick up the medium without any holding failure.

When the transport arm **36** moves up to pick up the medium M, the pressing lever **182** of the separation mechanism **131** pivots in the direction of arrow R3 in FIG. **21** about the connection point **181** and thus the operation piece **183** protrudes to the outside of the medium guide **133**.

Therefore, even if the second medium M is lifted up by adhesion to the lifted uppermost medium M, the operation piece **183** of the pressing lever **182** comes in contact with the inner circumferential surface Mb of the center hole Ma of the second medium M to satisfactorily separate the second medium, thereby lifting up only the uppermost medium M.

As described above, the medium transporting unit **31** according to the above-mentioned embodiment includes the separation mechanism **131** that separates the medium M just below the uppermost medium M to be held and lifted up by the holding mechanism **130**. Accordingly, even when the (second) medium M just below the medium M to be held is adhered thereto, it is possible to pick up and transport only the uppermost medium M without any holding failure by separating the just-below medium M.

The movable kick lever **182** having the operation piece **183** protruding outward in the diameter direction from the center hole Ma of the medium M and retreating is provided. Accordingly, by pivoting the kick lever **182** to allow the operation piece **183** to protrude at the time of holding and lifting up the uppermost medium M, it is possible to easily separate the just-below medium M adhered to the medium M to be held.

In addition, since the pivot mechanism **190** that pivots the kick lever **182** by lifting up and down the transport arm **36** is provided, it is possible to separate the medium M just below the medium M to be held by moving the kick lever **182**, without providing a specific driving mechanism.

Since the pivot mechanism **190** includes the lock **194** disposed in the vertical direction and the pinion **193***b* engaging with the lock **194** and the kick lever **182** is made to pivot by means of the rotational force of the pinion **193***b* rotating with the lift-up and lift-down motion of the transport arm **36**, it is possible to allow the operation piece **183** to protrude and retreat in the diameter direction by lifting up and down the transport arm **36** to easily move the kick lever **182**.

The pivot mechanism **190** includes the complex clutch gear **191** that can rotate by a predetermined angle at the time of lifting up the transport arm **36**. Accordingly, at the time of picking up the held medium M by lifting up the transport arm **36**, the kick lever **182** is made to move by a predetermined distance by the complex clutch gear **191** having rotated by a predetermined angle at the time of lifting up the transport arm **36** and it is thus possible to separate the medium M just below the holding object by allowing the operation piece **183** to protrude externally in the diameter direction by a predetermined distance.

At the time of lifting down the transport arm **36** so as to hold the medium M or to place the held medium M at a predetermined position, the kick lever **182** is made to pivot in the opposite direction by a predetermined distance by the complex clutch gear **191** having reversely rotated by a predetermined angle at the time of lifting down the transport arm **36**, and it is thus possible to insert the operation piece **183**, thereby preventing the operation piece **183** from interfering with the medium M to be held or the medium M to be placed.

It is preferable that the operation piece **183** is urged by the buffer spring **187** in a direction in which it protrudes, so that the operation piece does not move even when the kick lever **182** is made to pivot by a predetermined distance by the complex clutch gear **191**. This is, the operation piece is prevented from damage even when the medium to be held and the just-below medium are very strongly adhered to each other and they cannot be thus separated from each other or the operation piece **183** cannot move due to particles. It is preferable that the kick lever **182** includes two elements of the front lever portion **182***a* having the operation piece **183** and the rear lever portion **182***b* made to move by the complex clutch gear **191**. Such a configuration is effective for making the very small operation piece movable.

Since the publisher **1** includes the medium transporting unit **31** that can satisfactorily hold only the uppermost medium M stacked in the medium stackers **21** and **22**, it is possible to satisfactorily transport only a medium M to be held, thereby enhancing the processing reliability of the medium processing apparatus.

The invention is not limited to the above-mentioned embodiment but can be modified in various forms.

Although it has been described above that the kick lever **182** includes the lock **194** disposed in the vertical direction and the pinion **193***b* engaging with the lock **194** and the kick lever **182** is made to pivot by means of the rotational force of the pinion **193***b* rotating with the lift-up and lift-down motion of the transport arm **36**, the kick lever **182** may be driven by the publisher. Alternatively, although the kick lever **182** has included two elements, the kick lever **182** may have only one element, the operation piece portion may be provided as a particular element, and the operation piece **183** may be urged to the kick lever **182** in the protruding direction.

Although it has been described that the kick lever **182** is made to pivot by the complex clutch gear **191**, the kick lever **182** may be supported to be linearly movable by the arm base **125***a* and may be made to linearly move by the clutch gear **191**.

What is claimed is:

1. A medium transporting unit for transporting a top medium from a plurality of plate-shaped media accommodated in a stacker in a stacked manner, the medium transporting unit comprising:

a holding mechanism operable to hold the top medium, the holding mechanism including holding claws, wherein a downward protruding length of the holding claws is equal to or smaller then a thickness of both the top medium and a second medium positioned just

below the top medium when the second medium is accommodated in the stacker;

a transport arm provided with the holding mechanism;

and a lift mechanism operable to move up and down the transport arm,

a movable lever disposed on the transport arm and having an operation piece configured to move just below the top medium after the holding mechanism holds the top medium, wherein the transport arm is provided with a separation mechanism operable to separate the second medium when the second medium positioned just below the top medium exists,

wherein the separation mechanism includes a separation member which is movable so that the operation pieces comes in contact with an inner peripheral surface of a center hole formed on the second medium and being operable to move the operation piece to move the second medium in a radial direction thereof when the second medium positioned just below the top medium exists, and

wherein the separation mechanism is configured such that the operation piece of the separation member comes in contact with the inner peripheral surface of the center hole of the second medium and separates the second medium from the top medium during the lift mechanism moves up the transport arm after the holding mechanism holds the top medium when the second medium positioned just below the top medium exists.

2. The medium transporting unit as set forth in claim **1**, wherein the separation mechanism includes a moving mechanism operable to move the separation member so that the operation piece is located at a separation position where the operation piece comes in contact with the inner peripheral surface of the center hole to move the second medium in the radial direction thereof when the lift mechanism moves up the transport arm and the second medium exists, and the operation piece is located at a waiting position where the operation piece does not come in contact with the inner peripheral surface of the center hole when the lift mechanism moves down the transport arm.

3. The medium transporting unit as set forth in claim **2**,

wherein the moving mechanism includes a rack extending in a vertical direction and a pinion engaging with the rack; and

wherein the moving mechanism moves the separation member by a rotational force of the pinion which is rotated by the rack when the lift mechanism moves up and down the transport arm.

4. The medium transporting unit as set forth in claim **2**, wherein the moving mechanism includes a clutch gear rotatable by a predetermined angle when the lift mechanism moves up and down the transport arm.

5. The medium transporting unit as set forth in claim **1**, wherein the separation member includes a front lever portion having the operation piece and a rear lever portion moved by the moving mechanism.

6. The medium transporting unit as set forth in claim **5**,

wherein the separation member includes an elastic member operable to transmit a moving force applied to the rear lever portion to the front lever portion so that the operation piece applies an acting force to the second medium; and

wherein when a counteracting force from the second medium is more than a force of the elastic member, the elastic member deforms so as not to transmit the moving force to the front lever portion.

7. A medium processing apparatus comprising:

the medium transporting unit as set forth in claim **1**; and

a media drive having at least one of a function for writing data on the medium which is transported by the medium transporting unit and a function for reading data on the medium.

8. A medium transporting method by a medium transporting unit for transporting a top medium from a plurality of plate-shaped media accommodated in a stacker in a stacked manner, the medium transporting unit including a holding mechanism operable to hold the top medium, a transport arm provided with the holding mechanism, the holding mechanism including holding claws, wherein a downward protruding length of the holding claws is equal to or smaller then a thickness of both the top medium and a second medium positioned just below the top medium when the second medium is accommodated in the stacker, a lift mechanism operable to move up and down the transport arm, and a movable lever disposed on the transport arm and having an operation piece configured to move just below the top medium after the holding mechanism holds the top medium, the medium transporting method comprising:

holding the top medium by the holding mechanism;

moving up the transport arm by the lift mechanism after the holding; and

pivoting the lever to allow the operation piece to move just below the top medium after the holding and during the moving up.

* * * * *